

DEPARTMENT OF THE NAVY
HEADQUARTERS UNITED STATES MARINE CORPS
WASHINGTON, D.C. 20380

16 January 1976

FOREWORD

1. PURPOSE

FMFM 5-5C, Employment of Forward Area Air Defense Battery, sets forth doctrine for employment and control of the FAAD battery and its subordinate units within the Marine Corps.

2. SCOPE

This manual is designed to provide information and guidance concerning the organization, mission, employment, command and control, and the support requirements of the FAAD battery and the weapon(s) it employs. This manual has purposely excluded classified information, available in other manuals, in order to facilitate distribution and use throughout the Marine Corps.

3. SUPERSESSION

FMFM 7-7, Employment of Forward Area Air Defense Battery (U)(C), dated 24 September 1968.

4. CHANGES


Recommendations for improving this manual are invited from commands as well as directly from individuals. The attached User Suggestion Form should be utilized by individuals and forwarded to the Commanding General, Marine Corps Development and Education Command (Director, Development Center), Quantico, Virginia 22134.

PCN 139 000390 00

5. CERTIFICATION

Reviewed and approved this date.

BY DIRECTION OF THE COMMANDANT OF THE MARINE CORPS

A handwritten signature in black ink, appearing to read "J. C. Fegan". The signature is stylized with a large, sweeping initial "J" and "C" that are connected to the rest of the name.

J. C. FEGAN
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DISTRIBUTION: TEE

USER SUGGESTION FORM

From:

To: Commanding General, MCDEC
Development Center
Quantico, Virginia 22134

Subj: FMFM 5-5C; recommendation(s) concerning

1. In accordance with the Foreword to FMFM 5-5C, which invites individuals to submit suggestions concerning this FMFM directly to the above addressee, the following recommendation(s) is/are forwarded:

- a. ITEM #1 (May be handwritten; if more space is required, use additional sheets and envelope.)
 - (1) Portion of the Manual: (Cite by paragraph and/or page number.)
 - (2) Comment: (Explain in sufficient detail to identify the points of the suggestion.)
 - (3) Recommendation: (State the exact wording desired to be inserted into the manual.)

- b. Item #2
 - (1)
 - (2)
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RECORD OF CHANGES

Change Number	Date Entered	Entered By (Signature, Grade)

EMPLOYMENT OF
FORWARD AREA AIR DEFENSE BATTERY

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CHAPTER 1

FORWARD AREA AIR DEFENSE EMPLOYMENT

Section I. INTRODUCTION

1101. GENERAL

The capability to conduct successful air defense operations is essential to the execution of an amphibious operation. As a portion of this capability, the Marine Corps employs a highly mobile guided missile system through the forward area air defense (FAAD) battery. The FAAD battery and the missile system are responsive to the needs of maneuvering combat elements and are capable of engaging and destroying low flying fixed- and rotary-wing aircraft and reconnaissance drones.

1102. MISSION

The mission of the FAAD battery is to provide close-in air defense protection in forward combat areas, defense of vital areas, and defense of units engaged in independent operations by destroying hostile air supported threats. It is particularly essential in areas not defended by other elements of the air defense system. As the FAAD component of the anti-air warfare (AAW) system of the Marine aircraft wing (MAW), it performs the following tasks:

- a. Provides for battery operation, to include the capability of rapid deployment

ashore in an amphibious operation with integral command, control, and logistic support of the subordinate FAAD units.

b. Provides for the temporary deployment of separate FAAD units required to meet special tactical situations with required personnel and logistic support.

c. Plans and coordinates requirements for liaison and communications with appropriate commands to ensure the integration of FAAD unit operations with other air, ground, and AAW operations of the amphibious force.

d. Provides early warning of hostile air threats.

e. Conducts, supervises, and coordinates individual and unit training to qualify subordinate elements for tactical combat operations.

f. Performs first and second echelon maintenance of all organic equipment, excluding second echelon maintenance on weapons and trainers.

1103. HISTORY

a. Prior to the introduction of a light-weight shoulder-fired guided missile system, the caliber .50 machinegun was the best available AAW weapon to complete the umbrella of existing antiair defense (e.g., Nike Hercules, Hawk, etc.). However, with the introduction of high performance aircraft, the caliber .50 machinegun fell short of filling the gap of air defense against fast, low-flying air threats.

b. In June 1966, the Redeye Missile School was activated to train selected members of Fleet Marine Force (FMF) units in the operation and employment of the Redeye missile systems. The Redeye platoon was introduced into the FMF structure in September 1966 as part of each FMF division.

c. On 26 February 1969, an official table of organization (T/O) was effected for the FAAD battery, Marine air control group (MACG), MAW, FMF. The FAAD battery was placed in the MAW as a result of the decision to group all AAW assets under the command and control of the tactical air commander (TAC).

d. The missile system presently employed by the FAAD battery is an improved version of the Redeye system first introduced in the Marine Corps in 1966. Research and development continues to ensure that the latest weapon system is available for use by the FAAD gunner.

Section II. ORGANIZATION

1201. GENERAL

The FAAD battery is the primary unit within the MAW which provides close-in air defense protection for personnel and equipment in forward combat areas. The FAAD battery is organic to the MACG in the MAW. (See fig. 1.) When employed, it is task organized to provide air defense support for elements of the landing force in consonance with the overall air defense plan.

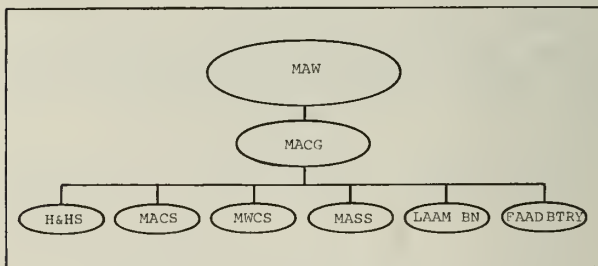


Figure 1.--FAAD Battery Attachment to Marine Aircraft Wing.

1202. FAAD BATTERY

The FAAD battery is normally considered adequate to support a Marine amphibious force. It consists of a battery headquarters, service platoon, and five FAAD platoons. (See fig. 2.)

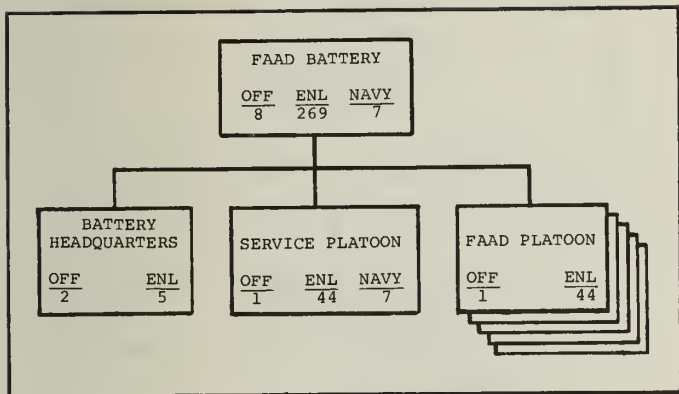


Figure 2.--FAAD Battery Organization.

a. Battery Headquarters.--The battery headquarters contains the command element and the battery administrative personnel.

b. Service Platoon.--The service platoon consists of a headquarters section, an operations section which incorporates the field radio operators and missile handlers, a maintenance section for motor transport support, and food service and medical sections. (See fig. 3.)

c. FAAD Platoon.--Normally, the FAAD platoon is considered adequate to support a Marine amphibious brigade (MAB). Each of the five platoons consists of a platoon commander, platoon sergeant, field radio operators, and three sections. (See fig. 4.)

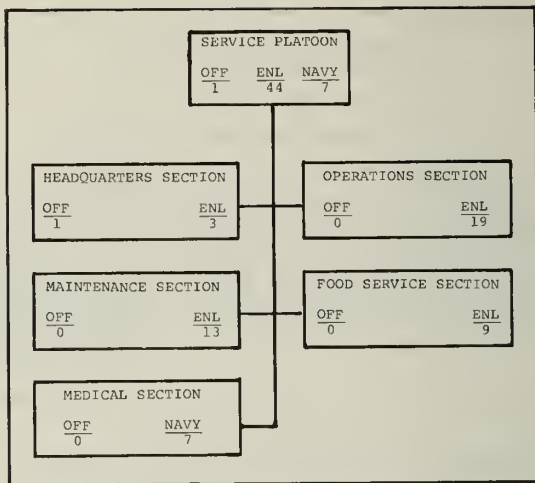


Figure 3.--Service Platoon.

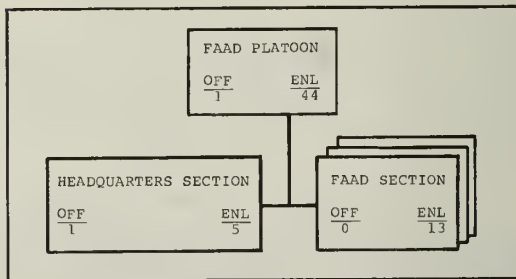


Figure 4.--FAAD Platoon.

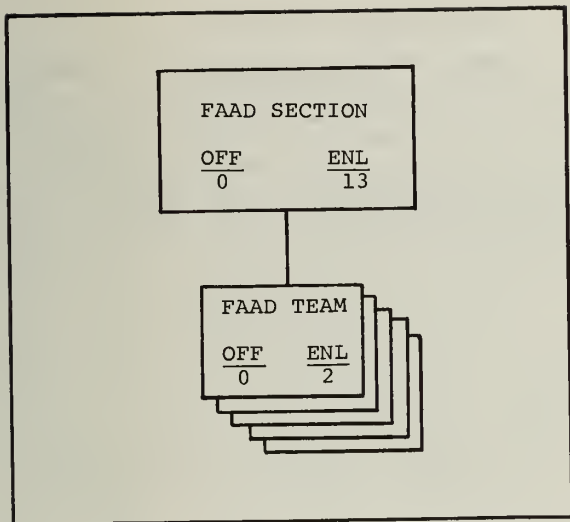


Figure 5.--FAAD Section.

(1) FAAD Section.--Normally, a FAAD section is considered adequate to support a Marine amphibious unit (MAU). When employed separately, an officer/SNCO will be placed in charge of the section. Each of the three sections consists of a section leader, two field radio operators, and five FAAD teams. (See fig. 5.)

(2) FAAD Team.--The basic operational fire unit of the FAAD battery is the FAAD team. It consists of a team leader/gunner and a motor vehicle operator/gunner.

1203. ADDITIONAL DUTY TEAMS

Selected personnel organic to the light antiaircraft missile (LAAM) battalion perform additional duty as FAAD gunners. Four teams are designated within each LAAM battalion. One team is normally designated in each of the missile batteries and one to the headquarters and service battery. Proficiency training is the responsibility of the LAAM battalion commander.

Section III. COMMAND, CONTROL, AND COMMUNICATIONS

1301. GENERAL

a. Air Control Coordination.--During amphibious operations, a single coordinated air control system is developed which is capable of controlling and coordinating all air operations within the amphibious objective area (AOA). Initially, this responsibility is vested in the commander amphibious task force (CATF). As the necessary facilities become operational ashore, responsibility for control and coordination is passed by increments to the commander landing force (CLF). Once command is passed ashore, the responsibility for the air control system is exercised by the tactical air command center (TACC).

b. Amphibious Task Force AAW Concept.--The AAW effort in the AOA integrates all available means into a single system that offers maximum control and protection, timely intelligence, and effective employment of resources. This is accomplished by exploiting the capabilities of each subsystem, integrating AAW early warning command and control capabilities, and achieving economy in use of weapon systems. The Marine air command and control system (MACCS) provides this capability ashore as shown in figure 6. Fighter and attack aircraft are the primary and longest range AAW weapons. They are complemented by the shorter range defensive weapons (Hawk and Redeye missiles).

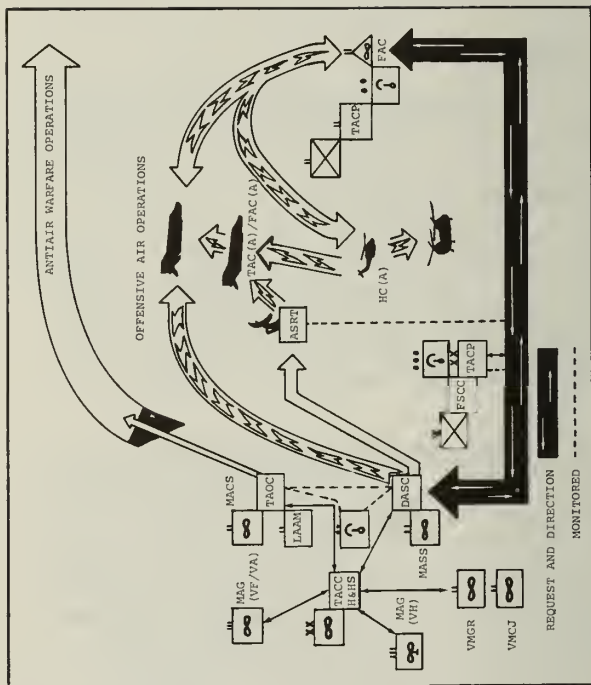


Figure 6.--Marine Air Command and Control System, Deployed.

Antiaircraft guns and surface-to-air missiles (SAM's) of the Navy contribute to the overall AAW system and provide protection to the amphibious task force.

c. FAAD Battery Integration.--During amphibious operations, AAW means must be projected ashore as early as possible. The mobility of FAAD battery weapons enable them to accompany the first elements of the landing force ashore. This flexibility enables an early integration into the overall air command and control system with FAAD units providing a balanced air defense throughout the combat area, complementing other elements of the air defense system.

d. FAAD Unit Assignments.--FAAD units are located with frontline elements to provide early AAW protection and then to cover those avenues of approach which are considered to be the most serious threat to the entire landing force. FAAD units are also assigned to protect vital areas and/or objectives in the AOA. In offensive situations, the teams are primarily responsive to the scheme of maneuver of the supported frontline units. In a defensive situation, the teams should complement each other and provide gap-fillers in the overall AAW defense.

1302. ORGANIZATION FOR COMBAT

a. In support of the landing, the FAAD units perform the following functions:

(1) Acquire, identify, engage, and destroy low-flying hostile aircraft.

(2) Coordinate with appropriate agencies to maintain friendly aircraft position information.

(3) Provide visual surveillance in assigned zones of fire.

(4) Provide an immediate reaction air defense capability in areas masked from other defense systems.

(5) Provide early warning of hostile air threats.

b. The tactical functions may be accomplished by organizing in the following manner:

(1) Support in a Static Situation.--

Under these conditions, the FAAD unit deploys its subordinate elements to best defend the supported force. Emphasis is placed on maintenance of overlapping fires and on coverage of low altitude attack routes identified by the commander landing force as threatening the operation. The FAAD unit commander will maintain command and control of all deployed teams. Teams should coordinate with the nearest unit commander for purposes of team security and messing.

(2) Support in a Fluid Situation.--

In this case, the FAAD units move with the supported elements as required for mission accomplishment, but otherwise remain under FAAD command and control. FAAD units depend on the supported unit for security and service support (rations, supply, etc.).

(3) Attached.--In order to maintain centralized control of all AAW assets in the AOA, FAAD units will not normally be detached from aviation command and control. However, if

a ground combat element is required to conduct independent operations such that control of FAAD units by the MACCS would not be feasible, then FAAD units may be attached. The command to which the FAAD unit is attached would exercise command and control subject to the specific guidance of the CLF.

(4) Responsibilities.--Appendix A amplifies responsibilities according to the situation.

(5) Reorganization.--As the air/ground combat situation changes, the FAAD units should be reorganized in a manner to best defend the AOA.

1303. FAAD COMMAND AND CONTROL

a. Marine Amphibious Force (MAF) Operations

(1) Command.--FAAD support for MAF level operations will be provided by the FAAD battery. Command of the battery is exercised through elements of the MACCS.

(2) Control Afloat.--During the early phase of an amphibious operation, control of air and AAW operations is vested in the CATF who exercises this responsibility through his tactical air officer. The FAAD battery commander, or his representative, will control FAAD units from the supporting arms coordination center (SACC). Weapons control conditions, air defense warning conditions, and antiair intelligence information will be received from the tactical air control center element of the SACC. FAAD platoon commanders will displace ashore with the supported units, maintaining communications with the battery commander, or his

representative, on the FAAD weapons control (FWC) net. The battery executive officer will displace the battery headquarters ashore with the landing force fire support coordination center (FSCC). While control of Redeye operations is afloat, the battery executive officer will function as FAAD liaison officer to the FSCC. In this capacity, he will monitor the FWC net and coordinate FAAD unit operations ashore.

(3) Control Ashore.--When the direct air support center (SASC) become operational ashore, the battery executive officer will move to the DASC, coordinating FAAD battery activities through this agency. Control of FAAD battery operations will continue to be exercised from the SACC through the CATF's AAW system until the tactical air command center (TACC) becomes operational ashore and control of AAW operations is passed to the CLF. When command is passed ashore, the battery commander will receive weapons control conditions, air warning conditions, and antiair intelligence information over the combat information/detection (CI/D) net and antiaircraft intelligence (AAI) net.

b. Marine Amphibious Brigade (MAB) Operations

(1) Command.--Support for an MAB level operation will be provided by the FAAD platoon. Command of the platoon is exercised through the MACCS.

(2) Control Afloat.--The FAAD platoon commander or his representative will control FAAD units from the SACC. Weapons control conditions, air defense warning conditions, and antiair intelligence information will be

received from the SACC. FAAD section leaders will displace ashore with the FSCC's of the supported units remaining communications with the platoon commander or his representative in the SACC over the FWC net. Normally, the platoon sergeant will displace ashore with the landing force FSCC. Functioning as the FAAD liaison to the FSCC, he will monitor the FWC net and coordinate FAAD unit operations ashore.

(3) Control Ashore.--When control of AAW is passed ashore to the CLF, the FAAD unit headquarters should be located in that MACCS agency which can best provide rapid early warning information and weapons control conditions. Selection of the agency which can best provide that information must be based on the tactical situation. Prime considerations are the availability of satisfactory communications, command, and control information from the TACC and the friendly air picture. Facilities will differ depending upon the tactical situation and the size of the operation (MAF, MAB, MAU). It is crucial that the FAAD headquarters maintain an awareness of the total AAW situation. When command is passed ashore, the battery commander will receive weapon control conditions, air warning conditions, and antiair intelligence information over the combat information/detection (CI/D) net and antiaircraft intelligence (AAI) net.

c. Marine Amphibious Unit (MAU) Operations

(1) Command.--Support for an MAU level operation will be provided by FAAD section(s). Command of the section(s) is exercised through the MACCS if available.

(2) Control Afloat.--The OIC/NCOIC of the FAAD section(s) will control the section(s) from the SACC. The assistant OIC/NCOIC (section leader) will displace ashore with the landing force FSCC maintaining communications with the FAAD OIC/NCOIC in the SACC over the FWC net. The assistant OIC/NCOIC acts as FAAD liaison officer to the FSCC and relays weapons control conditions, air defense warning conditions, and antiair intelligence information to the FAAD teams ashore over the FAAD team control (FTC) net.

(3) Control Ashore.--Normally for operations at the MAU level, control of air and AAW operations in the AOA remains with the CATF. If control of AAW operations is passed to the CLF, control of FAAD weapons will be exercised through the appropriate MACCS agency (TAOC or DASC).

1304. WEAPONS CONTROL AND COORDINATION

a. General.--The MACCS has the assets and the flexibility to coordinate and choose AAW weapons as the situation dictates. Air defense warnings and weapons control conditions are established by the CATF/CLF and disseminated over the MACCS communication nets. Local situations may allow subordinate unit commanders to impose restrictive weapons control conditions.

(1) FAAD Coordination.--The FAAD teams and command elements of the FAAD battery require considerable coordination for effective employment. The FAAD commander maintains current position and status information on all teams and disseminates weapons control conditions. The FAAD commander must be kept informed

of location and composition of detected or pending raids, engagements results, local air defense alert conditions, the status and location of "safe flight corridors," and the firing capabilities of LAAM battalion fire units. The FAAD commander provides information on friendly and hostile aircraft activity and engagement results to appropriate MACCS agencies.

(2) Fire Direction.--Fire direction of FAAD units includes target assignment and its relationship to zones of fire. The fire direction is the responsibility of the TAOC exercised through the FAAD commander for the FAAD teams. Firing coordination among LAAM and FAAD units is essential. The TAOC considers zones of fire, early warning, and target assignment when coordinating the fire of LAAM and FAAD units. For a detailed discussion of fire direction coordination for all AAW assets, see FMFM 5-1, Marine Aviation.

b. Air Defense Warnings.--The CATF or CLF evaluates the probability of air attacks and issues air defense warnings. The warnings are promulgated by the SACC or TACC. Air defense warnings are defined as follows:

- (1) RED: Attack is imminent or in progress.
- (2) YELLOW: Attack is probable.
- (3) WHITE: Attack is not probable.

c. Weapons Control Conditions

(1) Weapons Free.--This command means fire may be opened on all aircraft, except helicopters, not recognized as friendly. FAAD gunners may engage high speed aircraft not

positively identified as friendly. Engagement of helicopters requires positive identification.

(2) Weapons Tight.--The command means do not open fire, or to cease firing on any aircraft (or on bogey specified, or in section indicated) unless target(s) known to be hostile. FAAD gunners may engage any aircraft positively identified as hostile.

(3) Hold Fire.--This command means do not open fire or to cease firing on raid/track designated. FAAD gunners do not fire unless directly under attack by aircraft.

(4) Resume Fire.--This command is given to terminate the "hold fire" restriction.

(5) Cease Fire.--This command is normally given to air defense artillery units to refrain from firing on, but to continue to track visually, an airborne object.

(6) Cease Engagement.--This is an order for weapons to disengage a particular target or targets and prepare to engage another target. The order terminates engagement on a particular target.

d. Detection/Identification of Aircraft.
--Coordinated measures which help provide timely identification include information from visual, radar and identification friend or foe (IFF), flight plans, air corridors, flight characteristics, and the actions of observed aircraft.

(1) Friendly Aircraft

(a) Recognized as a friendly.
(b) Aircraft in a friendly corridor not committing a hostile act.
(c) Designated by control agency.

(d) Unidentified and not committing a hostile act.

(2) Hostile Aircraft

- (a) Recognized as an enemy.
- (b) Unidentified and attacking friendly installations.
- (c) Unidentified in areas where control agencies have specified all aircraft will be engaged.

e. Loss of Communications.--In the event of loss of communications, FAAD units are to go to "weapons tight" condition. If the previous condition was "weapons free," the "weapons tight" condition is assumed immediately. If prior to communication loss, the weapon was in "hold fire" status, FAAD units will maintain "hold fire" for a period of 10 minutes and then assume "weapons tight." Loss of communication procedures should be instituted if the FWC and/or FTC communication nets are down.

f. Authority to Change Control Conditions.--Authority to change the FAAD weapons control conditions is vested in the commander landing force and is normally exercised by the tactical air commander through the TACC. In independent operations, this authority is vested in the senior organizational commander. It is anticipated that the normal weapons control condition will be "weapons tight" and that changes will be infrequent. It is possible that the tactical situation may require a momentary change in the weapons control condition status within a local commander's area. The following criteria will apply:

(1) Area Control Agency.--In either a "weapons free" or "weapons tight" status, the approximate MACCS control agency may direct

"hold fire" when appropriate or may direct engagement of targets.

(2) Local Tactical Commander.-- Organizational commanders to which FAAD teams are attached may, when the tactical situation requires, set weapons control conditions for their local area which imposes additional restraints on the FAAD gunner.

1305. STANDING OPERATING PROCEDURES (SOP'S)

SOP's will cover, but not be limited to, the following:

a. An operational log should be maintained by each FAAD detachment from the section to battery level. This log will contain a chronological record of events pertaining to the unit's operation.

b. Action reports should be submitted as directed via the FAAD unit chain of command. These reports will cover a specified period of time and be consolidated at each echelon and forwarded to the next higher command to arrive at a time to be designated in the operation order. Typical information would include enemy sightings, engagements, helicopters, and kills.

1306. COMMUNICATIONS

The destructive capabilities of the lightweight air defense weapon system employed by the FAAD battery combined with the predicted density of friendly aircraft overflying the AOA dictate that absolute control be exercised over the use of FAAD weapons. Due to the wide dispersion and mobility of FAAD battery elements

throughout the AOA, radio is the primary means of satisfying these control requirements. Wire should be used in a static situation. The communications of the FAAD battery in the MACCS are shown in figure 7.

a. Responsibility.--The FAAD battery commander is responsible for battery communications. He will ensure that:

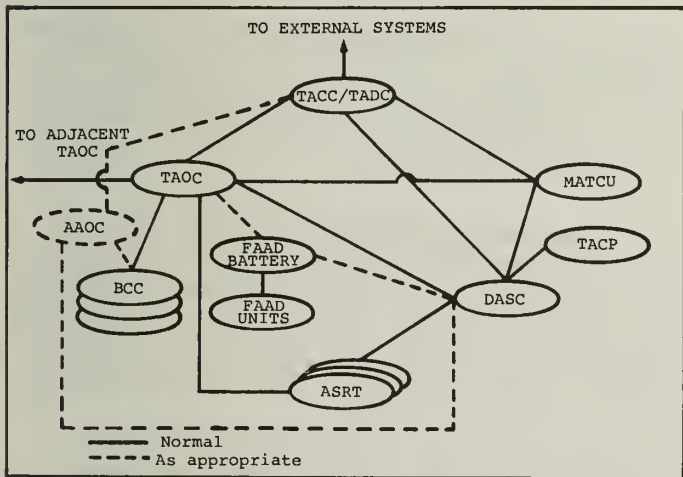


Figure 7.--Communications of the FAAD Battery in the Marine Air Command and Control System.

(1) The establishment, maintenance, control, coordination, and employment of communications is in accordance with current doctrine and applicable directives issued by higher authority by preparing and promulgating specific methods and procedures.

(2) All personnel required to operate telecommunication equipment are qualified by establishing an organized training program.

(3) Alternate communication means, as available and required, are used for effective communication support of battery operations.

b. FAAD Battery Communication System.-- In order for air defense warnings, weapon control conditions, and pertinent information concerning friendly, enemy, or unknown aircraft as well as necessary FAAD battery command information to be exchanged, the following communication nets may be required:

(1) FAAD Weapon Control (FWC) Net (HF).--The FWC net is established by the senior FAAD representative in the SACC or the appropriate MACCS agency. Multiple nets may be required. This net provides subordinate units with current air defense warnings, weapons control conditions, and pertinent information concerning friendly, enemy, or unidentified aircraft. The following stations are on this net:

(a) FAAD battery' commander
(SACC/appropriate MACCS agency).

(b) FAAD platoon commander(s)
(regimental FSCC or appropriate MACCS agency).

(c) FAAD section leaders (battalion FSCC).

(2) FAAD Team Control (FTC) Net (VHF).
--The FTC net is established by the section leader

normally located in the FSCC of the supported unit. Multiple nets may be required. This net is used by the section leader to control FAAD teams and relay air defense warnings, weapons control conditions, and pertinent information concerning friendly, enemy, or unidentified aircraft. The following stations are on this net:

(a) FAAD section leaders (battalion FSCC).

(b) FAAD teams.

(3) Activation.--These communication nets would be activated when FAAD teams are deployed in support of infantry units. FAAD teams assigned to support other units have similar requirements. In each employment, specific coordination will be effected to ensure communication requirements are satisfied and any unique problems of FAAD support in that given environment are considered. Careful communication planning and detailed coordination are prerequisites to effective control.

c. Alternate Communication Means.--In the case of loss of communications, FAAD unit leaders and FAAD teams should attempt to utilize FSCC communication nets. The FSCC controls communication nets for coordination of all supporting arms. Landing force representatives in the SACC (air, naval gunfire, and artillery) have established nets with the FSCC for control of supporting arms that parallel the FWC net. The air liaison officer in the FSCC is in contact with the DASC when it is established ashore. Redeye unit leaders in the FSCC could establish communications with Redeye teams supporting company and/or battery level units on such nets as the TACP local, shore fire control party (SFCP)

local, and artillery conduct of fire communication nets utilized by the FAC and NGF spot teams.

d. Supplemental Communications

(1) The manner in which elements of the FAAD battery are employed may require the use of other communication means. Both visual and sound systems may be developed and employed as necessary. They are coordinated and published in applicable communication standing operating procedures/annexes to operation plans prior to use.

(2) If other communication means are not available or operating, the arm-and-hand signals shown in figure 8 may be used.

e. FAAD Additional Duty Teams.--These teams have control requirements similar to FAAD battery teams. They are always employed within the parent LAAM battalion and are controlled through the antiair operation center (AAOC). This is accomplished by using existing communication nets to the AAOC and the battery control central (BCC) in the missile batteries and by wire from the BCC to the associated FAAD team. The FAAD team from the headquarters and service battery should be linked directly with the AAOC by wire.

f. Communications Security.--Communications security (COMSEC) results from all measures designed to deny unauthorized persons information which might be derived from the possession and study of communications. COMSEC includes physical, cryptographic, and transmission security. Maximum use will be made of COMSEC capabilities and assets.

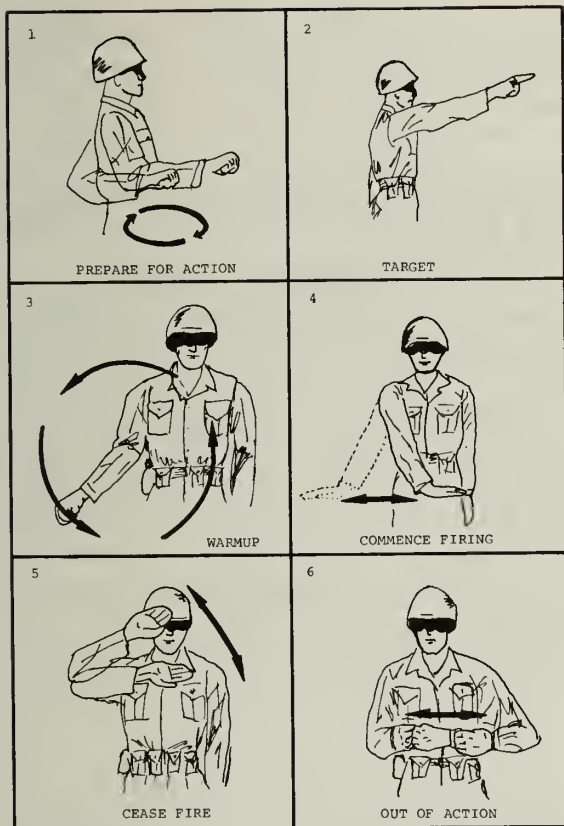


Figure 8.--Arm-and-Hand Signals Used With FAAD Teams.

(1) Physical Security.--Physical security is that part of COMSEC concerned with all physical measures necessary to prevent unauthorized access to equipment, information, and documents, and to safeguard them against espionage, sabotage, loss, damage, and theft.

(2) Crypto Security.--Crypto security is the element of COMSEC which deals with the provision of technically sound cryptographic systems and the proper use of authorized codes and cipher devices.

(3) Transmission Security

(a) Transmission security is that component of COMSEC which includes all measures designed to protect transmissions from unauthorized interception and exploitation.

(b) Strict circuit discipline and adherence to authorized procedures are the primary means which provide transmission security over radio circuits. All personnel who operate radios must be trained to recognize and avoid improper practices which endanger radio transmission security. This includes violation of radio silence, unofficial conversation between operators, use of plain language in place of applicable prosigns or operating signals, and failure to maintain radio watches on designated frequencies and at prescribed times.

Section IV. EMPLOYMENT

1401. GENERAL

FAAD battery units are task organized to provide close-in air defense to the landing force in consonance with the overall AAW plan. Teams are located with frontline elements in order to provide their air defense. In addition to being employed to provide protection for maneuver elements, FAAD units are assigned to protect vital areas when no other ground-based air defense means are available, a situation likely to exist in early phases of amphibious operations. In offensive situations, the teams are primarily responsive to the scheme of maneuver of the frontline unit. In a defensive situation, the teams should complement each other and fill gaps in the overall AAW plan.

1402. EMPLOYMENT CONSIDERATIONS

a. FAAD Planning.--Planning is the responsibility of the CATF afloat and of the CLF ashore. Planning should include, but not be limited to, the following factors:

(1) The air threat, to include air delivery methods and tactics.

(2) Mission and disposition of the defended unit(s)/installation(s) and commander's guidance.

(3) Elements or installations to be defended in order of priority.

- (4) The ground threat.
- (5) FAAD capabilities and limitations.
- (6) Availability of firing and alternate firing positions.
- (7) Command and control criteria.
- (8) Location and coverage of other air defense means.
- (9) Disposition/control procedures while embarked.

b. Intelligence Briefings.--Intelligence briefings covering disposition of friendly and enemy forces, the enemy air threat, likely avenues of approach to the AOA for fixed and rotary wing aircraft, enemy tactical air doctrine, general terrain, and weather will enhance the FAAD team's ability to perform its mission. This information should be provided to the FAAD unit commander prior to any tactical operation and updated regularly over the appropriate FAAD or alternate net.

c. Offensive Operations.--During offensive operations, FAAD units are most frequently employed in direct support of the maneuver and reserve tactical elements or headquarters and support areas. When in support of the maneuver elements, FAAD units must maintain mobility to allow for repeated displacement to sites best suited for AAW support.

(1) Preparation for the Attack.--Map and ground reconnaissance should be made with particular attention given to selection of firing positions and low level aircraft

approach corridors along the planned route of advance. Radio frequencies must be known by all unit members and keying material for secure voice equipment must be on hand. Procedures must be established for resupply of FAAD weapons.

(2) Motor Convoys.--In a column, FAAD units should be placed both at the front and the rear of the column, with prime consideration given to early and continuous engagement of the air threat along the axis of the column's movement. FAAD unit members must have their weapons unpacked and ready to fire. They must be prepared to dismount, assume the best available firing positions, and engage the air threat on short notice without violating safety criteria. The commander may choose to place units at critical points along the route of the column to ensure the necessary observation and coverage. Locations such as bridges, defiles, and passes, where an air attack could halt the entire column, are considered critical points.

(3) Dismounted Operations.--The FAAD unit normally dismounts to defend maneuver elements in difficult terrain and in the assault. The two team members are most effective operating as a team. The basic load for the FAAD team consists of four weapons in monopaks, a secure voice radio, and the normal T/O weapon and pack. The supported unit must be prepared to provide security for FAAD equipment left in the rear and to assist in carrying the team's basic load of FAAD weapons. Without assistance, the FAAD team is limited to two weapons as the weight of the FAAD team's load places physical limitations on their range and mobility during dismounted operations.

The unit should cover the final assault from preselected positions offering the best chance for FAAD defense and survivability.

d. Defensive Operations.--Defensive operations usually allow a greater degree of control and coordination of FAAD support and the selection of optimum firing positions. The FAAD unit will normally occupy prominent terrain overlooking the supported unit's defensive position and should be retracted at night if its position is outside the supported unit's perimeter.

(1) Mutually Supporting Fires.--Mutually supporting fires are desirable and enhance the probability of a kill. Quite frequently, mutual support will not be achieved due to the disposition of the supported unit and terrain features. FAAD units must be positioned to provide mutual support to the maximum extent possible, but not at the expense of the tactical disposition of units or the site selection criteria covered above.

(2) Integration into the AAW Plan.--During a static situation, the FAAD unit may be assigned to a gap filler role and specific firing sites by the CLF. The FAAD unit should continue to draw normal logistic support from the supported unit.

e. Tactical Firing Site Selection.--FAAD unit firing positions must be the best available sites for the accomplishment of the mission. Since the FAAD weapon's backblast is easily identifiable, other available firing positions should be designated as alternate

positions to allow rapid displacement after firing. The location of firing positions should be coordinated by the senior FAAD commander with the air defense control agency and the local tactical commander. The initial selection of firing positions will be by map reconnaissance followed by ground/aerial reconnaissance when time, transportation, and the tactical situation permit.

(1) Observation.--FAAD units use visual means for detection and recognition of targets. Surveillance is maintained in all directions with emphasis on the most likely direction of attack. FAAD positions should be selected to allow detection of low-flying aircraft at ranges consistent with the optimum capability of the weapon. One team member continuously performs surveillance of the surrounding air space, alternating with the other member as required. They may be separated by short distances where observation is limited.

(2) Fields of Fire.--The gunner must have good fields of fire along the most probable routes of approach of hostile aircraft. The FAAD unit leader selects a firing position which minimizes the effect of vegetation and terrain mask, allows engagement of low-flying aircraft at the optimum ranges of the weapon, and minimizes direct or reflective effects of the sun.

(3) Accessibility.--Although not a primary consideration, the FAAD firing site should be readily accessible by the unit's organic vehicle to maintain mobility and facilitate supply.

(4) Cover and Concealment.--In

selecting firing positions, consideration must be given to cover and concealment. The position should provide natural cover which enhances the ability to camouflage the position. If natural cover is not available, foxholes or bunkers should be prepared to provide protection from enemy fire. In camouflaging the position, consideration should be given to visibility from the air as well as from enemy ground observation.

(5) Safety.--Missile backblast requires that the FAAD weapon be fired from an open position and that gunner positions should be clear of excessive dry brush, tall grass, or other materials which might ignite when the weapon is fired. A circular zone around the firing position should be kept clear to permit the team to fire in all directions.

1403. LEVEL OF EMPLOYMENT

MAF, MAB, and MAU operations are normally supported by FAAD batteries, FAAD platoons and FAAD sections respectively. However, the degree of FAAD support assigned to the landing force must be assessed during the planning phase based on the planning and operational considerations discussed in this section. In addition to being tasked with protection of ground combat elements, FAAD units may be assigned to command, combat support, or service support elements to provide protection to vital areas, such as command posts, logistic support areas, communication installations, and air facilities.

1404. NIGHT EMPLOYMENT

The Redeye weapon has a night tracking and kill capability which is equal to or superior to that in daytime. However, the total weapon system is dependent on the gunner's visual aircraft identification, target acquisition and IR lock, and range estimation. As a result, the FAAD weapon will not normally be employed at night.

1405. TRAINING

a. Identification.--Protection of friendly aircraft requires that positive visual identification be made prior to FAAD engagement. Identification training must include:

(1) A vigorous aircraft recognition program (initial and continuing).

(2) Frequent exercises (both integrated Mablex/Maulex and local tracking drills).

(3) Implementation of early warning via MACCS.

(4) Recognition of friendly/hostile aircraft action.

(5) Exercise of weapons control conditions.

(6) Use of friendly aircraft flight information (DASC and TAOC).

(7) Use of friendly aircraft corridors.

b. Weapon Handling and Firing

(1) General.--The FAAD gunner must

be proficient in handling his weapon, utilizing it to engage an aircraft, and firing procedures. A training program can be conducted in a classroom which will enable gunners to:

(a) Receive, inspect, transport, and protect the weapon.

(b) Perform preventive maintenance.

(c) Prepare the weapon for firing.

(d) Conduct a successful engagement.

(2) Tracking Drills.--Tracking drills should be conducted regularly on the initiative of the platoon commander. Site(s) should be identified which present realistic flight profiles in terms of ordnance delivery techniques. The tracking head trainer and the Redeye launch simulator (RELS) should be used to enhance sequence of engagement training.

(3) Annual Regualification.--It is essential that the FAAD platoon commander monitor the regualification of assigned gunners and plan firing exercises to maintain qualifications in accordance with current directives.

c. Tactical Employment and Control.--A comprehensive knowledge of tactical employment, field operations, and control procedures must be learned by the FAAD gunner. This knowledge encompasses:

(1) Principles and functioning of the weapon.

(2) Capabilities and limitations.

(3) Safety precautions.

(4) Aircraft recognition of U.S., Allied, and enemy aircraft.

(5) IR signature characteristics for typical aircraft.

(6) Rules of engagement.

(7) Weapons control conditions.

(8) Air defense warnings.

(9) FAAD communication system procedures.

(10) Surveillance techniques.

(11) Firing doctrine.

(12) Map reading and principles of site selection.

(13) Assigned communication equipment and communication security.

(14) Methods of weapon destruction.

(15) Required reports.

d. Physical Conditioning.--In dismounted operations, FAAD units are required to deploy with FAAD weapons, radios, normal T/O weapons, and field pack. A vigorous physical conditioning program will ensure that FAAD teams are capable of performing effectively in this role.

e. Evaluation.--Formal testing, using procedures established at the battery level, should be accomplished periodically in aircraft identification, using the Ground Observer Aerial Recognition (GOAR) kit and other training devices. Additionally, handling and firing procedures should be evaluated in a formal manner. The overall effectiveness of the FAAD training program is best evaluated by participation in integrated field exercises under the observation of qualified umpires. Appendix C is a sample umpire's checklist.

1406. SECURITY CONSIDERATIONS

Adequate security for the FAAD unit is important to prevent compromise and hostile use of the weapon. While selection of positions for the FAAD unit is the responsibility of the FAAD unit leader, local security for the FAAD unit is the responsibility of the commander of the supported unit and should not detract from the supported unit's mission. Accordingly, FAAD unit leaders must coordinate with the supported unit commander in selecting firing positions and evaluating enemy capabilities for attack. If enemy ground attack is expected, the positions should be located well within the perimeter of the supported unit.

1407. FAAD ANTIAIR WARFARE PLANNING

Antiair warfare is defined as operations conducted against aircraft and/or missiles, their supporting forces, and operating bases. Antiair warfare comprises all measures, both active and passive, employed in achieving and maintaining air superiority. Since antiair warfare is an integral part of the overall amphibious operation, planning and execution of this effort is closely coordinated with all other operations in the objective area. It is possible that the FAAD detachment might be the only antiair warfare system employed in an operation, but it is more likely that the Redeye weapon will be just one part of the antiair warfare commitment. In either case, the concept of operations for antiair warfare (to include FAAD unit operations) will normally be expressed in

the antiair warfare annex to the operation order. Its format generally follows the standard five-paragraph form (see FMFM 3-1, Command and Staff Action).

Section V. ADMINISTRATION AND LOGISTICS

1501. ADMINISTRATION

a. Garrison.--In garrison, the FAAD unit is under the administrative and operational control of the MACG. The FAAD unit may be assigned to a subordinate unit of the MACG.

b. Direct/General Support.--When employed in direct or general support, administrative and operational control of FAAD units remains with the aviation combat element.

c. Attachment.--When attached to a ground combat element, administrative and operational control is transferred to the combat element.

1502. LOGISTICS

a. General.--The principles and procedures of logistic support for FAAD units are similar to those of other FMF organizations. The FAAD battery is capable of providing most of the normal support functions such as maintenance, supply, food service, and medical. However, due to the requirement to deploy separate platoons/sections and the dispersion of FAAD teams necessary to support maneuver elements, FAAD units/teams must often rely on the supported unit for a major share of logistic support.

(1) Authorized Allowances.--Instructions and guidance which will assist a commander in computing materiel requirements for the performance of assigned missions will be found in the Table of Authorized Materiel (TAM). Logistic planning data are included for classes I and III, as well as guidance relative to type 3 (Special Measures of Control) items within classes II, IV, and VII. General instructions in the TAM provide pertinent information which includes applicable allowance publications.

(2) Responsibilities of Commanding Officers.--The FAAD unit Table of Equipment specifies authorized allowances for the FAAD unit and includes additional instructions regarding the responsibilities of the commanding officer.

b. Logistic Support

(1) Supply

(a) General.--The FAAD battery has a limited capability for organic supply. All technical manuals and repair parts lists prepared by the U.S. Army will be used by the FAAD battery. The battery commander will coordinate the supply requirements for subordinate elements. Platoons and sections deployed separately must rely on supply support from the unit to which administratively assigned or from the supported unit.

(b) FAAD Weapon.--The basic load of the FAAD team is four weapons. Resupply follows normal class V procedures and is the responsibility of the FAAD unit commander.

(2) Equipment.--A technical description of the Redeye system is contained

in section VI. The major items of equipment, other support equipment, and tools unique to the Redeye weapon system are as follows:

(a) Guided Missile System, Intercept-Aerial: M41E2 (Redeye). One Redeye weapon and three battery/coolant units are loaded, transported, and stored in the shipping and storage container (Monopak). Once the weapon has been fired, the launcher will be recovered if the tactical situation permits. Expended launcher tubes will be returned to the ammunition supply point.

(b) Test Set, Guided Missile System AN/TSM-82: Guided Missile Test Set.

(c) Training Set, Guided Missile System, M76 (Redeye).

(d) Redeye Launch Simulator (RELS).

(e) Guided Missile, Intercept-Aerial Training, M46A2 (Redeye).

(f) Shipping and Storage Container, Guided Missile System: M571 (Monopak) (Redeye).

(3) Maintenance.--The FAAD battery is capable of organizational maintenance for assigned motor transport and communications equipment. Platoons and sections deployed separately must rely on maintenance support from the unit to which administratively assigned. The maintenance plan for the Redeye weapon system assumes a high degree of reliability for the system. Maintenance functions are delegated to the lowest organizational level commensurate with tools, skills, and time available.

(a) Organizational maintenance on the Redeye weapon, the guided missile test set, the tracking head trainer, the field

handling trainer, and Redeye launch simulator is limited to replacement of parts which do not require tools, inspection, cleaning and replacement of batteries, and protecting and cleaning the exterior surfaces of all units.

(b) Intermediate maintenance is not permitted on any weapon, training or test unit.

(c) Depot maintenance on the Redeye weapon will be performed at designated U.S. Army Depots. It will be performed on the guided missile test set and tracking head trainer at the calibration facility of the Marine Corps Supply Centers. Depot maintenance on the Redeye launch simulator will be performed as directed by Headquarters Marine Corps.

CHAPTER 2

WEAPON SYSTEM

Section I. DESCRIPTION

2101. GENERAL

The Redeye missile is an infrared seeking, passive homing missile. The missile responds to radiation in the infrared frequency spectrum and uses this radiation to guide itself to the target.

a. Nature of Infrared Radiation (IR).--Infrared radiation is radiation of electromagnetic energy in the frequency spectrum beginning just above that of red visible light. All substances in nature radiate infrared energy. The amount and character of IR radiation depends on the temperature of the substance. IR energy has properties similar to light energy, traveling in a straight line and at the same speed as light (approximately 186,000 miles per second).

b. Redeye Infrared Seeker.--The Redeye seeker acquires the IR energy emitted by a target and signals the gunner by an audible signal produced by the weapon, tracking head trainer, and RELS. The seeker is designed to detect IR radiation in the frequency spectrum emitted by hot metal parts associated with aircraft exhaust and tailpipes. The IR detector is made more sensitive to target

energy as it is cooled by the gas from the battery/coolant unit (BCU). The Redeye seeker is capable of detecting target IR radiation and producing the acquisition signal within 3 to 5 seconds after activation.

2102. WEAPON COMPONENTS

The Redeye weapon consists of three major elements: the missile, launcher, and battery/coolant unit. The total weight of the weapon is approximately 29 pounds. The launcher (see fig. 9) contains the means for assisting the gunner in acquiring the target, prelaunch conditioning, and firing the missile. The BCU (see fig. 10) provides the electrical power required to prepare the weapon for firing, and the coolant required to prepare the missile seeker for target acquisition and tracking. The missile (see fig. 11) is sealed within the launcher to provide protection during transportation and against climatic conditions. A shoulder sling is attached to the launcher for carrying the Redeye when it is not enclosed in the storage container. Figure 12 shows the Redeye in the firing position. The remaining elements of the system are a shipping and storage container, a test set, and three training devices--an intercept-aerial trainer, a field handling trainer, and a Redeye Launch Simulator (RELS). (See fig. 13.) Figure 14 illustrates the Redeye Guided Missile System Data.

a. Launcher.--The launcher (see fig. 9) consists of three main sections: launch tube, gripstock, and sight assembly. The launcher

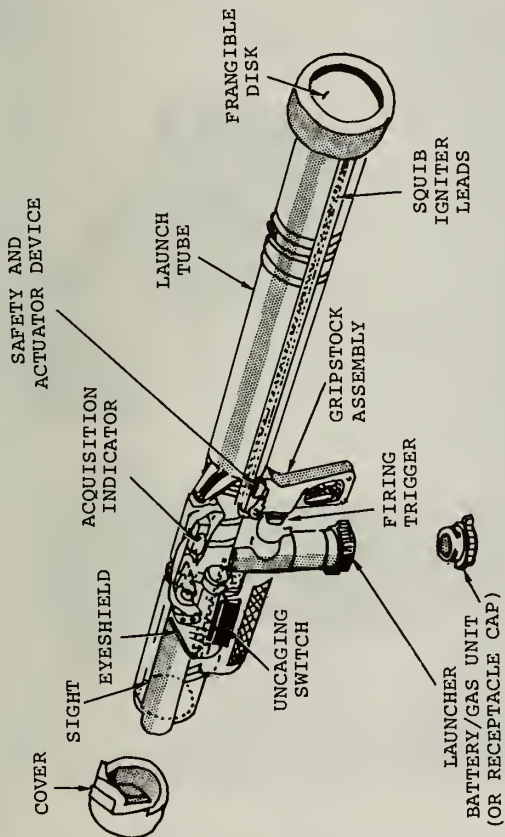


Figure 9.--Redeye Launcher XM41E2 (Exploded View).



Figure 10.--Battery/Coolant Unit.

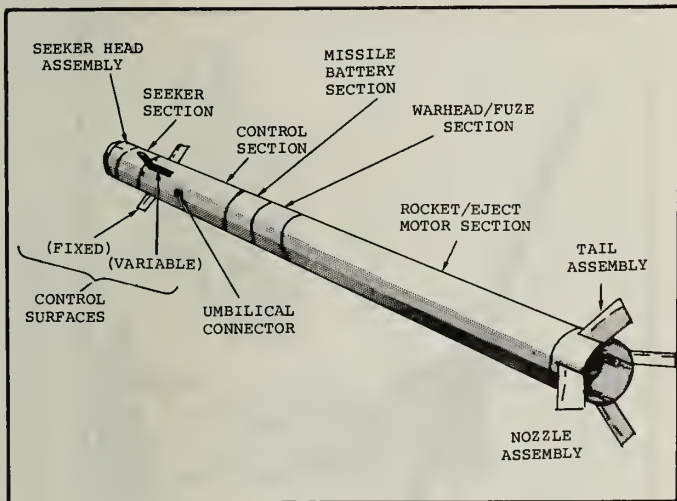


Figure 11.--Redeye Missile.



Figure 12.--Redeye in the Firing Position.

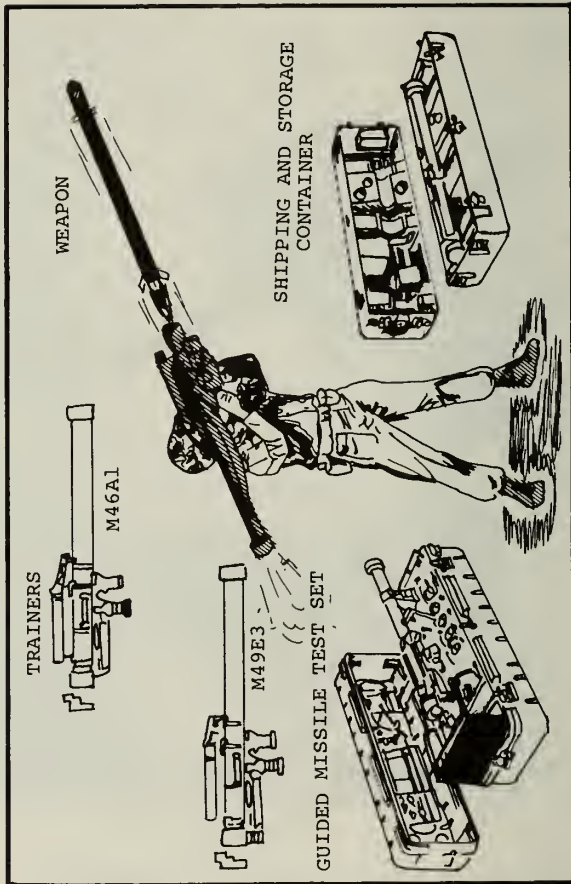


Figure 13.--Redeye Guided Missile System

STEM	LENGTH	WIDTH	HEIGHT	DIAMETER	WEIGHT
Redeye Weapon (Complete With Caps and Battery Coolant Unit) (M4LE2)	50.5 In.	4.7 In. (Sight Folded)	10.9 In. (Sight Folded)	--	28.9 Lbs.
Missile	47.5 In.	--	--	2.75 In.	18.0 Lbs.
Launcher (Without Caps, Sling, and Battery Coolant Unit)	49.7 In.	--	--	3.61 In.	8.5 Lbs.
Battery Coolant Unit	6.0 In.	--	--	2.1 In.	1.2 Lbs.
Shipping and Storage Container (Monopak) (M571)	56.5 In.	17.5 In.	12.5 In.	--	--

Figure 14.--Redeye Guided Missile System Data.

provides the gunner with a means of transporting, aiming, and firing the missile. The electrical connection between launcher and missile is made through a connector assembly (umbilical) which is retracted just prior to missile launch.

(1) Launch Tube.--The launch tube contains the missile and is the main support for all other parts of the launcher. The forward end of the tube contains electrical coils which provide for seeker gyro spin to the prelaunch spin rate. The front and rear ends of the launcher tube are sealed with frangible discs. These discs seal the missile within the low humidity environment maintained in the launch tube; the front disc being a filter, transparent to the infrared radiation required to allow the missile to acquire the IR source while sealed within the launch tube. The front disc is broken upon missile ejection, and the rear disc is blown away by "eject" motor blast.

(2) Gripstock.--The launcher gripstock assembly is attached to the lower forward end of the launch tube. It contains controls, electronic modules, BCU receptacle, and coolant tubing necessary to condition and launch the missile. The coolant tubes to the missile shear upon missile ejection. The pistol grip, near the center of balance of the weapon, is the natural right-hand point. Located forward of the grip is the BCU receptacle which has a receptacle cap installed during storage and transportation of the weapon. The controls included with the gripstock consist of the safety and actuator device, uncaging switch, and the firing trigger.

(a) Safety and Actuator Device.

--The safety and actuator device is a manually operated mechanism which, when activated, provides the necessary electrical pulse required to energize the BCU.

(b) Uncaging Switch/Bar.--The uncaging switch/bar is a manually operated switch used to uncage the gyro allowing the detector cell to remain locked on the IR source independent of slight movements of the launcher during the firing sequence.

(c) Firing Trigger.--The manually operated firing trigger electrically energizes the missile, and after a short delay to accommodate component stabilization and umbilical retraction, ignites the eject motor.

(3) Electronic Modules.--The electrical power required to prepare the weapon for firing is supplied by the battery portion of the BCU. Electronic modules located within the gripstock provide prelaunch power and signal distribution to the missile through the umbilical assembly.

(4) Coolant.--The coolant required to bring the detector within the low temperature range for optimum acquisition of an IR source is supplied by the coolant portion of the BCU. Distribution to the seeker/detector of the missile is by means of a coolant tube from the BCU through the gripstock into the missile.

b. Missile Round.--The missile (see fig. 11) consists of seven major sections: seeker section, control section, missile battery, fuze and warhead, rocket motor, "eject" motor, and tail assembly.

(1) Seeker Section.--The seeker section contains the seeker head (gyro optics unit) and electronic modules. The seeker receives IR energy from the target and produces an audible acquisition signal which informs the gunner the target has been acquired. After launch, it generates signals to the control section which are used to correct the flight of the missile, steering it to the target. A detector cell within the seeker detects the IR radiation from the target and converts it into electrical signals which are used to keep the seeker locked on the target. Automatic seeker tracking of the target IR radiation occurs when the gyro is uncaged prior to launch and during missile flight.

(2) Control Section.--The control section is made up of an electronic unit and motor-driven control surfaces (wings). Two pairs of wings, folded when the missile is in the launch tube, unfold and lock into place when the missile is fired. One pair is fixed while the other pair is controlled by a set of gears driven by an error steering motor. An electronic unit provides the power and signals to the steering motor. The signals received are error signals indicating the missile is not in the proper flight path, and the steering motor moves the wings the required amount to direct the missile to the target. At launch, the umbilical is retracted and the missile battery then provides the required power to the seeker and control sections.

(3) Missile Battery Section.--The missile battery section provides the electrical power for the missile during flight. The battery contains an electrolyte which is inactive at normal temperatures, but is activated

from the heat produced by ignition of the fuze strips located between battery cells. Battery activation, initiated by pulling the firing trigger, produces the necessary voltage output within 0.5 seconds after ignition of the thermal fuze strips. This causes a slight delay in missile launch after pulling the fire trigger.

(4) Fuze and Warhead Section.--The fuze and warhead section consists of a fuze and warhead.

(a) Fuze.--The fuze functions are to ignite the sustainer rocket motor after missile ejection at the proper time and to arm and detonate the warhead. The fuze also includes safety features to ensure the Redeye is safe for shipping and handling. The fuze timer is activated when the missile has reached sufficient acceleration. The timer controls sustainer ignition, arming of the warhead, and self-destruction of the missile in the event the missile does not contact the target.

(b) Warhead.--The warhead is not armed and cannot be detonated until the missile is launched and is a safe distance from the gunner. The warhead, when armed, can be detonated in any one of three ways: upon penetration of the metal surface of the target; by impact of the missile striking the target; or by self-destruction after approximately 15 seconds of missile flight.

(5) Rocket-Motor Section.--The rocket motor, or sustainer, contains a solid propellant which provides thrust to accelerate and propel the missile in flight. Following missile "eject" and "coast," the sustainer motor fires and burns for approximately 5.6 seconds.

(6) "Eject" Motor.--The "eject" motor consists of a solid propellant which provides the thrust necessary to eject the missile from the launch tube. The propellant, which is completely expended before the missile leaves the launch tube, also provides initial missile spin. When the trigger is pulled, power from the launcher BCU fires the "eject" motor (after the required delay for the missile battery to attain activation). Following "eject" motor burnout, the missile coasts for approximately 7 meters prior to ignition of the sustainer motor.

(7) Tail Assembly.--The tail assembly consists of four folding stabilizing fins. Prior to firing, the fins are in a folded position within the launch tube. When the missile is fired, the ejection motor gases strike the folded canted tail fins, causing the missile to spin counterclockwise. Upon missile ejection, the tail fins snap into place and are locked in flight position. They continue the counterclockwise spin, a necessary function of missile guidance throughout flight.

c. Battery/Coolant Unit (BCU).--The battery/coolant unit (see fig. 10) is a cylindrical case with an insulated plastic cap on the bottom. It consists of a thermal battery which energizes the launcher electrical circuits during the prelaunch sequence and a coolant gas supply bottle which supplies coolant gas to maintain the required low temperature in the IR detector in the missile seeker. The BCU is inserted in the launcher prior to activation of the weapon. The unit is activated by the safety and actuator device on the launcher. Once activated, the battery

will supply electrical power for a minimum of 30 seconds. A hollow needle on the BCU enters a sealed port in the launcher coolant supply line when the BCU is inserted in its receptacle. The coolant gas is released into the supply line simultaneously with the activation of the BCU. Each BCU is used once and then discarded. In the event the BCU is activated and the engagement is aborted with no attempt to fire, the BCU must be replaced prior to another attempt to engage. Three BCU's are issued with each weapon.

2103. SHIPPING AND STORAGE CONTAINERS

The monopak shipping and storage container, M571, is a two-piece fungus and moisture resistant aluminum shell with a capacity of one Redeye weapon and three BCU's. Saddle type polyethylene padded supports hold the weapon firmly within the container. The BCU's are contained in firm formfitting receptacles. The container is designed to provide the weapon with protection against shock and vibration encountered during all modes of transportation, including palletized airdrop. The construction of the container will allow stacking seven tiers high in storage. When the container is closed, 10 latches provide sufficient sealing pressure to ensure a spray-tight seal under all operating conditions. The weapon is readily accessible by releasing the latches and removing the lid. Handles are provided to facilitate lifting and handling. These handles are positioned to allow two men to effectively transport or load the containers.

2104. TEST SET

The Redeye guided missile test set AN/TSM-82 (see fig. 13) is used to determine the operational readiness of the Redeye missile, the tracking head trainer, and RELS. For further information, see TM 9-1400-425-35.

2105. TRAINING DEVICES

There are four training devices used to train personnel in the operation and handling of the weapon.

a. Tracking Head Trainer.--The tracking head trainer (see fig. 15) is a full-scale model similar to the actual Redeye weapon in weight, size, operation of controls, and pre-launch operational characteristics. The trainer provides all functions of the weapon except actual missile launch. The trainer is T/E equipment of the FAAD battery. When used during training exercises, they provide the gunner an excellent device in maintaining gunner proficiency. They also provide an effective means of evaluating gunner performance. For a full discussion of the trainer, see appendix B.

b. Field Handling Trainer.--The field handling trainer (see fig. 13) is an expended launcher which has been ballasted to simulate the weight and balance of the tactical weapon. It is used only for familiarization and has no functional components. For a full discussion of the trainer, see appendix B.

c. Redeye Launch Simulator (RELS).--The



Figure 15.--Redeye Tracking Head Trainer M49E3 With Battery.

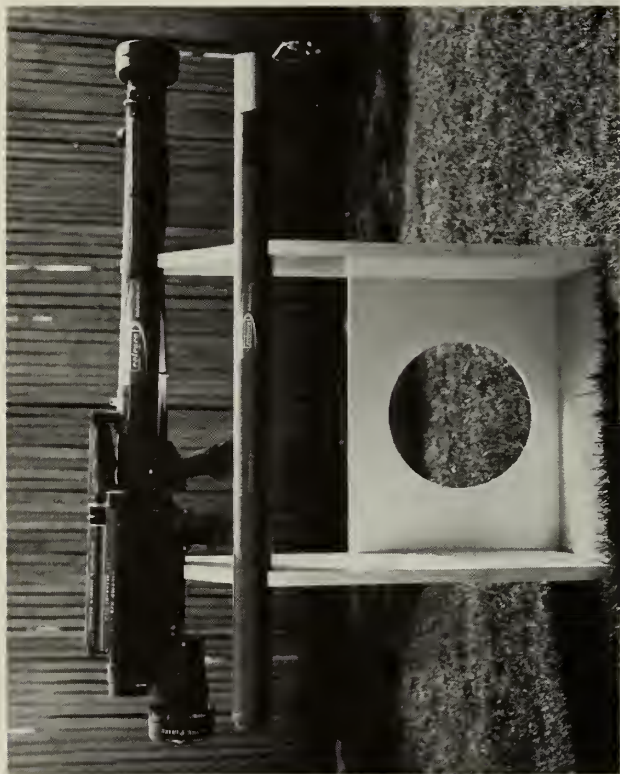


Figure 16.--Redeye Launch Simulator (RELS).

RELS (see fig. 16) is a training device that duplicates all functions of a Redeye missile launch. The RELS utilizes an eject motor to ballistically launch an inert missile to a maximum range of less than 350 feet. Safety considerations require a range area clear of obstructions and personnel extending a minimum of 350 feet forward and 42 feet rearward of the launch area. For a full discussion of this trainer, see appendix B.

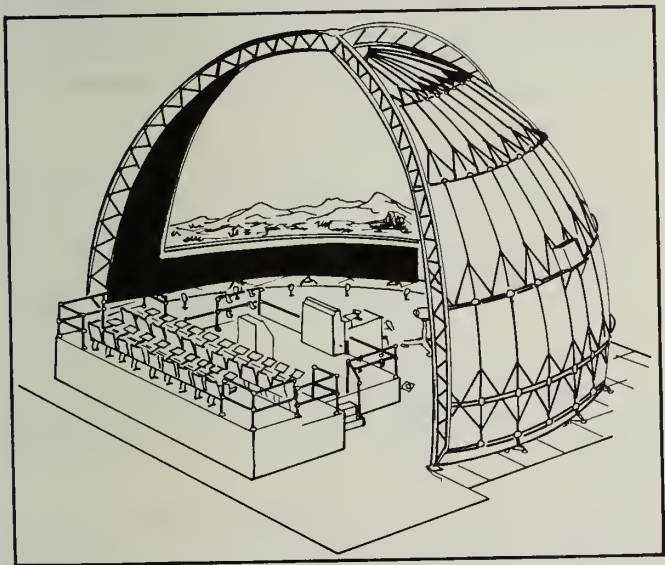


Figure 17.--Redeye Moving Target Simulator Trainer, Device M87.

d. Redeye Moving Target Simulator (MTS).--The MTS (see fig. 17) is a training device used to train Redeye gunners in the proper use of the Redeye weapon. It incorporates the use of the tracking head trainer against the flight of moving aircraft on a large screen. The aircraft are projected on the screen by the use of a movie projector and a series of mirrors. An invisible IR source is superimposed over the aircraft which is only present as it would be if the aircraft was actually flying. It also incorporates actual sounds of the flying aircraft including fixed-wing and helicopters. For a full discussion of this trainer, refer to appendix B.

Section II. WEAPON FUNCTIONS

2201. GENERAL

This section describes the functional sequence of firing the Redeye weapon. The functional sequence begins when a potential hostile aircraft has been detected. Steps in Redeye weapon functioning are discussed below.

2202. WARMUP

Operation of the safety and actuator device provides an electrical impulse which activates the launcher BCU. Due to warmup delay and limited battery life, the Redeye weapon must be activated at the correct range and normally must be fired within approximately 30 seconds after activation of the BCU. The following events occur during warmup of the Redeye weapon (see fig. 18):

a. Launcher BCU Activated.--Operating the safety and actuator device activates the launcher BCU which provides power for the missile and launcher and starts the gas coolant flow for prelaunch conditioning of the weapon.

b. Gas Coolant Flow.--Coolant gas flows from the BCU through the supply tube to the IR detector which is cooled to minus 100 degrees Fahrenheit within 5 seconds and then exhausts to the atmosphere through the exhaust tube. Gas supply lasts 35 seconds.

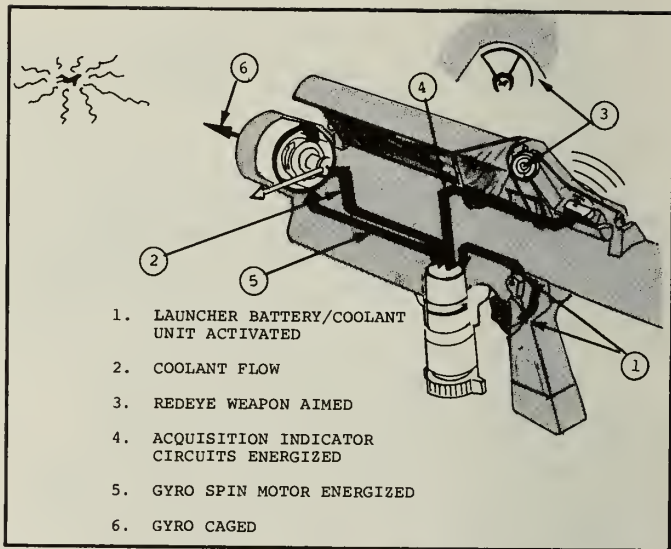


Figure 18.--Events During Warmup.

c. Weapon Aimed.--The Redeye weapon is aimed so that the target image appears in the center of the sight ranging ring.

d. Acquisition Indicator Circuits Energized.--The speaker circuits are energized by the launcher battery. These acquisition circuits indicate when the IR seeker has acquired the target. The weapon has a transducer (speaker) which provides an audible signal to

the ear and vibrations to the gunner's cheek-bone to indicate acquisition.

e. Gyro Spin Motor Energized.--The gyro spin motor is energized by the launcher battery and starts to spin the gyro to full speed. The speaker provides an audible indication of gyro spin-up.

f. Gyro Caged.--The launcher battery energizes the gyro cage circuit so the gyro is directed to an electrically caged position to be bore sighted to the gunner's line of sight.

2203. ACQUISITION

Assuming that the target is within range and provides enough IR energy to activate the seeker, 3 to 5 seconds will be required before an acquisition signal can be obtained after activation. This delay allows the gyro in the missile to obtain proper operating speed and for the detector cell to be cooled sufficiently. When the seeker senses the target, the acquisition indicator sounds. If the gunner wavers off the target in the caged condition, the audible signal will change tone or cease. The following occurs during the period in which the target is acquired (see fig. 19.):

a. An IR detector cell in the seeker senses an IR signal and converts it into an electrical output which is applied to the acquisition indicator circuits.

b. The indicator circuits then apply the signal to the transducer where an audible tone is transmitted and the transducer vibrates.

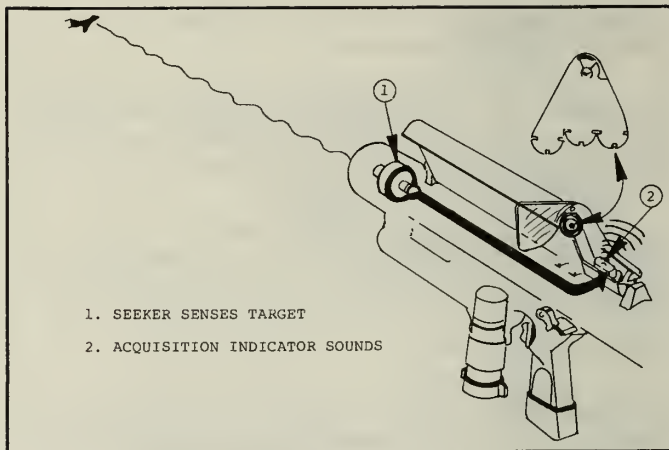


Figure 19.--Acquisition.

2204. UNCAGING THE GYRO

When acquisition signals are obtained, the gunner presses and holds the uncaging switch (see fig. 20). This action allows the missile seeker to track the target independently of launcher movement. The gunner will notice a change in the tone of the acquisition signal when the uncaging switch is pressed as the seeker accurately and automatically tracks the infrared source. The gunner must ensure the IR acquisition tone is present prior to insertion of superelevation and lead.

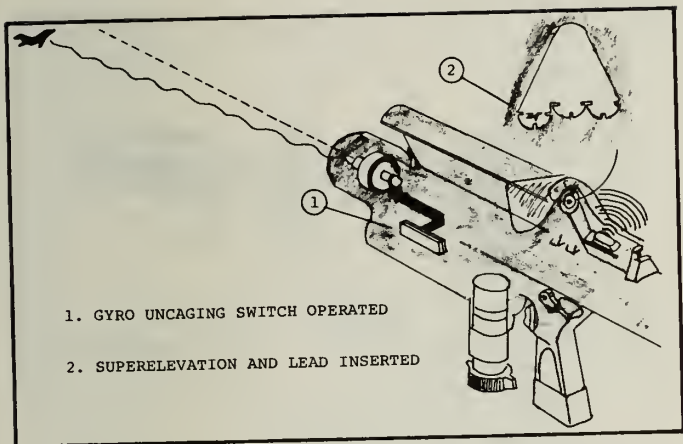


Figure 20.--Gyro Uncaged; Seeker Tracking.

2205. SUPERELEVATION AND LEAD

Raising the launcher to an angle above the line of sight to the target is called applying superelevation. (See fig. 21). When the target is within the launch zone, superelevation (and lead as necessary) is inserted by moving the weapon to properly reposition the target image in one of the three lower semicircles of the sight. Superelevation (and lead as necessary) is not inserted until just prior to firing. Should a gunner fire at a low-flying target and not apply superelevation, the missile could strike the ground prior to sustainer ignition. The gunner must also

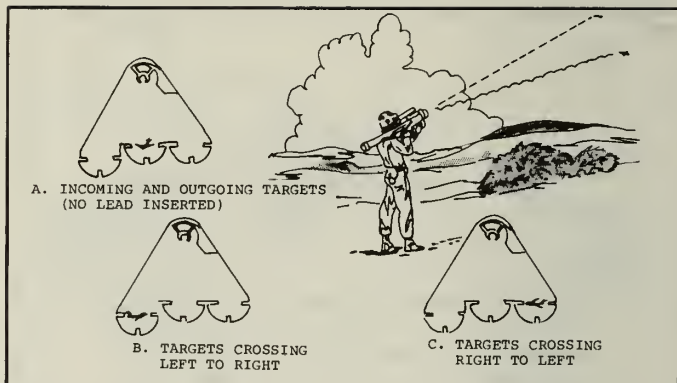


Figure 21.--Determine Target Is in Launch Zone and Apply Superelevation (Insert Lead as Required).

ensure the acquisition tone is still present after inserting superelevation (and lead as necessary) prior to firing.

2206. FIRING THE MISSILE

When the Redeye team has identified the target as hostile, the gunner has determined it is within the launch zone, and superelevation (and lead as necessary) has been inserted, the weapon is fired by pulling the trigger (see fig. 22). The firing trigger must remain pressed, the uncaging switch must be held down, and the gunner must continue a followthrough track on target for about 1 second until the

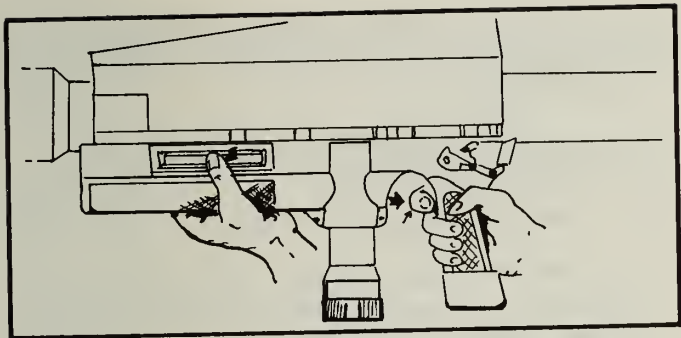


Figure 22.--Press and Hold Down Firing Trigger; Continue to Track Target.

missile clears the launch tube. There is no recoil when firing the Redeye weapon, only a slight twist counterclockwise and a change in the weight of the launcher as the missile is ejected. If the firing trigger has not been pressed and there is sufficient BCU time remaining, the gunner can release the uncaging switch and reacquire a lost target or acquire a new target. If the firing trigger has not been pressed and the mission is aborted, a new BCU is required to make the weapon ready for another engagement.

a. Missile Battery Activated.--Pressing the firing trigger activates the missile battery.

b. Umbilical Retract.--The umbilical is

retracted from the missile approximately 0.5 seconds after the firing trigger is pulled, depending on the electrical output of the missile battery.

c. "Eject" Motor Fires.--Retraction of the umbilical causes the "eject" motor to ignite in the launch tube.

2207. MISSILE EJECTION

When the "eject" motor fires, the

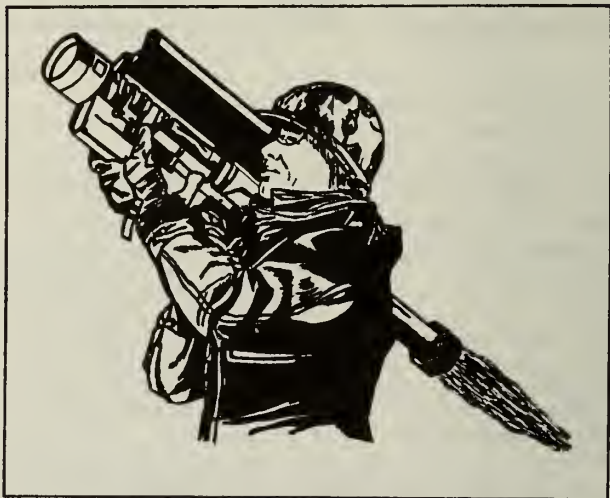


Figure 23.--Press and Hold Firing Trigger; Ejector Fires.

missile starts spinning and then leaves the launch tube (see fig. 23). This motion is caused by the canted position of the folded tail fins in the "eject" motor exhaust stream.

a. Missile Spin.--Before the missile leaves the launcher, it is spinning at full rate (12 RPS) by the force of the ejector motor exhaust against the still-folded canted tail fins.

b. Fuze Timer Starts.--When the missile reaches an acceleration of 28 g's, the initial switch in the fuze timer closes and the fuze timer starts. The ejector motor is completely expended before the missile leaves the launcher.

2208. MISSILE COAST

From the force imparted by the "eject" motor, the missile coasts approximately 7 meters from the gunner before the sustainer motor fires (see fig. 24). As the control wings and tail fins clear the launch tube, they snap out and lock in place. The control wings are spring loaded, and the tail fins are brought into position by the spinning of the missile. To compensate for missile drop in elevation during the coast phase, superelevation must have been inserted prior to firing.

2209. SUSTAINER MOTOR IGNITION

In this phase, the sustainer motor ignites, the fuze timer initiates warhead arming and the self-destruct cycle is started. (See fig. 25.)

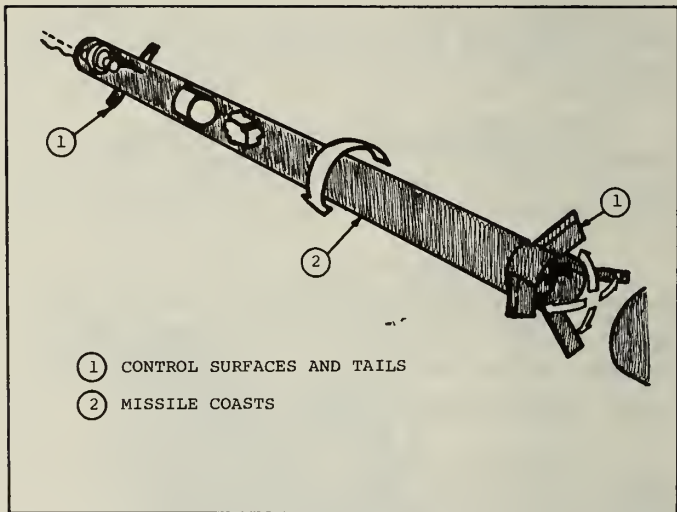


Figure 24.--Missile Coast.

a. Sustainer Motor Ignites.--A fuze activates the sustainer motor firing circuit 0.31 seconds after the missile is ejected. At this time, the missile is approximately 7 meters from the gunner. This delay ensures that the missile is clear of the gunner before the sustainer motor ignites.

b. Warhead Arming.--The fuze arms the warhead 1.6 seconds after the fuze timer starts (provided the missile has reached sufficient acceleration).

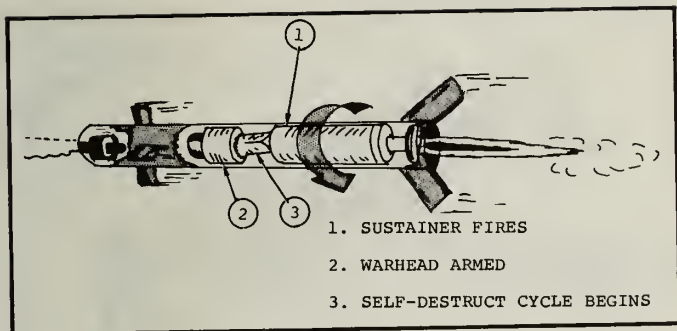


Figure 25.--Sustainer Motor Ignition and Warhead Arming.

c. Self-Destruct Cycle.--At the time the warhead is armed, the self-destruct cycle is started.

2210. GUIDANCE

In the guidance phase of operation, the seeker guidance system detects any difference between the line of flight of the missile and the seeker line of sight (see fig. 26).

a. Tracking the Target.--The seeker section detects differences between the seeker (gyro) line of sight and the source of target IR energy. This tracking error signal is used in a tracking servo-loop to correct the attitude of the gyro so as to continuously aim the missile at the target.

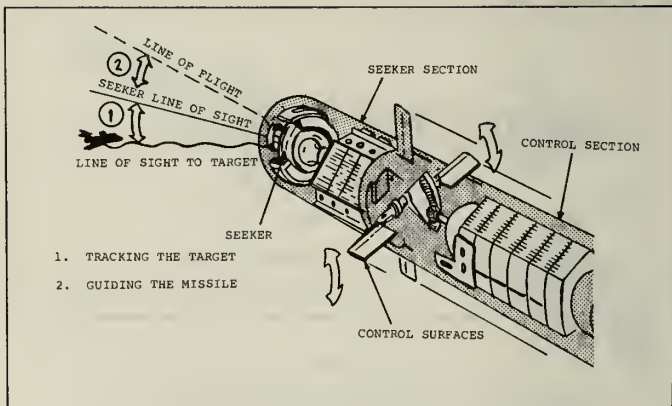


Figure 26.--Guidance.

b. Guiding the Missile.--The control section, using the tracking output signal supplied by the seeker, generates steering commands which are applied to the moveable control surfaces. Proportional navigation is used in guiding the missile on a collision course to the target.

2211. WARHEAD DETONATION

In the final phase, the warhead either explodes on target penetration or impact, or is destroyed in flight by a self-destruct mechanism (see fig. 27).

a. Target Hit.--The warhead will be detonated by one of two methods when the

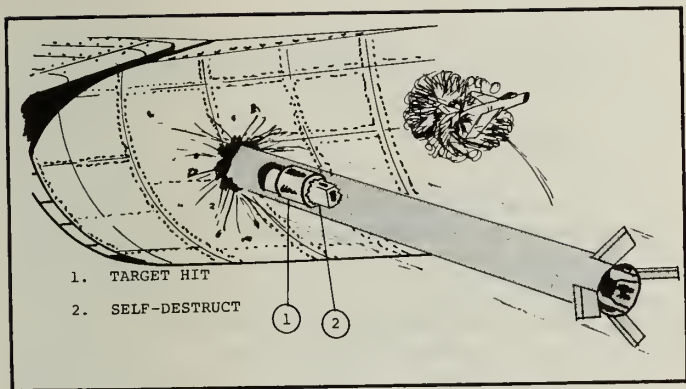


Figure 27.--Warhead Detonation.

missile hits the target:

(1) The penetration impulse generator will detonate the warhead as the missile body penetrates the metal skin of a target.

(2) An impact switch will detonate the warhead if the missile impacts and does not penetrate the skin of the target.

b. Self-Destruct.--If the missile does not hit the target, the warhead will be detonated by a self-destruct system approximately 15 seconds after launch.

Section III. ENGAGEMENT PROCEDURES

2301. GENERAL

a. The basic techniques necessary for a FAAD gunner to successfully engage a target are an extremely important part of the training and knowledge of each FAAD gunner. These techniques include visual detection of targets, determination of target course, determination of target type, recognition of target, and ranging of the target.

b. The engagement procedures discussed below are:

- (1) Target detection and search and scan procedures.
- (2) Aircraft characteristics and recognition.
- (3) Infrared radiation acquisition of targets.
- (4) Ranging techniques and ranging profiles.
- (5) Conduct of fire.

2302. TARGET DETECTION AND SEARCH AND SCAN PROCEDURES

The first step in the Redeye engagement sequence is to locate the target. Team members act either alternately or simultaneously as observers in a tactical situation, thus target detection may be made by either member. The effectiveness of the Redeye weapon system may

be increased by early visual detection of hostile aircraft. The FAAD headquarters element must receive and interpret early warning information passed via the various communication nets and be able to convert significant information into a form that can be rapidly disseminated to and utilized by the FAAD teams. Similarly, appropriate FAAD team detection and engagement data should be entered by the FAAD headquarters into appropriate nets.

a. Factors Affecting Visual Detection.

--The FAAD team member is the human link in the detection process. His efficiency and effectiveness is dependent primarily on his state of training but may vary from moment to moment as a result of his motivation or because of events taking place in his field of view that may distract his attention. Major factors that affect the ability of the FAAD team member to detect aircraft are visual acuity, size of the assigned search sector, target characteristics, and environmental conditions.

(1) Early Warning.--The ability of the Redeye gunner to visually detect and recognize low-altitude aircraft is increased by adequate early warning. Early warning is information concerning possible enemy air activity to include location, direction of approach, number of aircraft, and any other data disseminated to air defense units. Early warning information is gathered from such sources as forward observers, friendly aircraft, and radars. Early warning communication facilities may give advance warning from a few seconds to a few minutes before an aircraft is

sighted. The detection range is greater when there is adequate early warning, good visibility, and no terrain masks.

(2) Visual Acuity.--Redeye personnel are required to visually detect, recognize, and identify aircraft. This requires that they have at least average visual acuity.

(3) Search Sectors

(a) Visual search is the systematic visual coverage of a given area. This method of surveillance is used by the Redeye team member. (See FM 1-80, Aerial Observer Techniques and Procedures, for a discussion of search and scan procedures.) Systematic visual search takes advantage of the inherent capability of human vision to detect fine detail.

(b) A search sector is defined as a limited portion of the gunner's entire field of observation.

(c) Factors influencing the size of search sectors are: distance between Redeye teams, visibility, terrain masks, the limits of human observation, and the availability of early warning.

(4) Search Sector Size.--In general, the range of visual aircraft detection increases with a decrease in the size of the search sector assigned to the FAAD team. If a search sector of 360 degrees is assigned, targets may approach closer to the defended area before detection than if the search sector is narrowed, for example to 45 degrees.

(5) Target Characteristics.--The ranges at which aircraft can be detected vary greatly with specific conditions. In addition to visual acuity and search sector size, the

most critical variables which affect detection are target and environmental characteristics.

(a) Size of Target Profile.--

Target size has a great effect on detection range. For example, a large bomber jet aircraft can be detected at a far greater range than a smaller jet aircraft.

(b) Target Speed.--In general, detection range decreases for a particular target as its speed increases.

(c) Target Altitude and Heading.--Both the altitude and heading of aircraft influence detection range. Crossing targets usually can be detected at greater ranges than the same targets on courses directly toward or away from the observer, because crossing targets present larger profiles.

(d) Target Color.--An aircraft whose color contrasts with its background is visible at greater distances than an aircraft which has been camouflaged or is of a color which blends with the background.

(6) Environmental Characteristics

(a) Visibility.--Visibility conditions vary widely in different parts of the world. Factors that reduce visibility include fog, haze, dust, smoke, rain, and clouds.

(b) Illumination.--The visibility of an aircraft is influenced by its contrast with the background against which it is viewed. The contrast is in part dependent on the position of the sun in relation to the target.

(c) Terrain Masking.--Terrain masking results from the existence of mountains, hills, trees, buildings, or clouds between the gunner and the target.

b. Methods of Search and Scan.--FAAD team members employ visual search and scan procedures to detect approaching hostile aircraft. The technique of thoroughly covering the area or sector of search for the presence of targets is termed visual search. Visual search is conducted from the gunner position and generally includes a specific field of view. FAAD positions are selected to take advantage of the most favorable terrain. Because early warning information may not be available, the FAAD team employs definite search and scan procedures to prevent surprise attack by enemy aircraft. This method of visual search is called scanning. Scanning is a step-by-step method of looking at the ground and sky. Two procedures are suggested for search and scan, one for use in flat terrain, the other for use in hilly terrain. In each procedure, the individual should focus on a distant object, cloud, or terrain feature every few seconds so that the eyes remain focused on distant objects. If not, the eye will relax and distant objects will become blurred.

(1) Flat Terrain.--In the daytime, the observer's line of vision has to stop on an object to see it in detail. When the gunner moves his line of vision rapidly across a flat horizon, he will see very little detail. When the gunner moves his line of vision in short steps from point to point, he is more likely to see detail. The recommended search and scan technique for flat terrain observation is shown in figure 28.

(2) Hilly Terrain.--In the case of hilly terrain, the gunner should scan the sky using the horizon as a starting point as shown

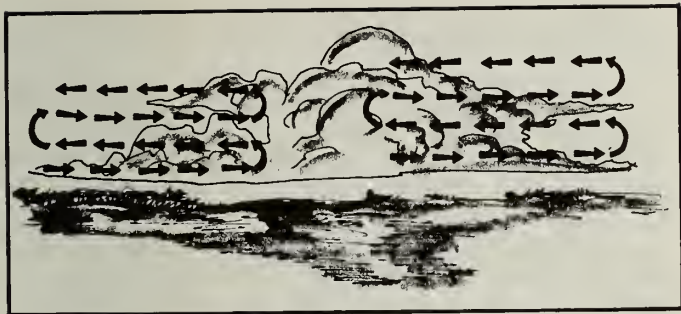


Figure 28.--Search and Scan Techniques
in Flat Terrain.

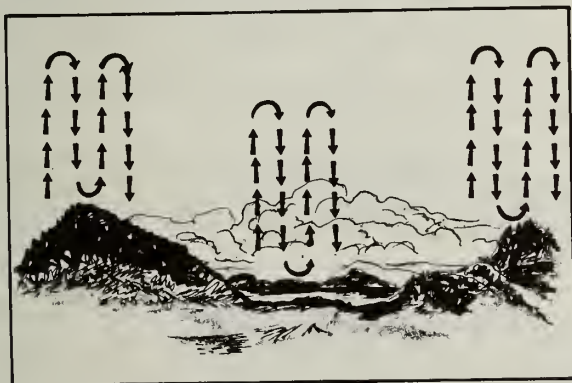


Figure 29.--Search and Scan Techniques
in Hilly Terrain.

in figure 29. Prominent features are used as points of reference.

c. Search and Scan Duties.--Alternating search and scan duties will reduce fatigue on both team members. One member searches for aircraft while the other member performs other team duties. Gunners should not look for aircraft for periods longer than 40 minutes at one time. Unless the team has been alerted to the approach of potential hostile aircraft, only one team member should be searching for enemy aircraft. Procedures for surveillance when a specific search sector has not been assigned include:

- (1) Search all likely avenues of aircraft approach to the defended position.
- (2) Divert attention occasionally to other sectors to prevent surprise by hostile aircraft.
- (3) Search the entire horizon (360 degrees) periodically.

d. Target Track.--Following visual detection, the gunner continues to observe the aircraft to determine the aircraft type, aircraft track (flight path), and the target size profile.

- (1) Aircraft Type.--Aircraft type is discussed in paragraph 2303.
- (2) Aircraft Track.--The aircraft track is the flight path of the target as viewed by the gunner. Determination of the track is particularly important during engagement of a high performance target and is used by the gunner to estimate crossover. Crossover

is the midpoint of the target flight path to the gunner position where the aircraft is closest to the gunner and the rear portion of the aircraft is beginning to be presented to the gunner's field of view. Target direction is determined to be incoming-crossing, outgoing-crossing, incoming-overhead, or outgoing-overhead. An incoming-crossing or outgoing-crossing target crosses offrange from the gunner position more than 500 meters. An incoming-overhead or outgoing-overhead target flies directly overhead or within 500 meters of the gunner's position.

2303. AIRCRAFT CHARACTERISTICS AND RECOGNITION

a. General.--One of the primary factors in the FAAD engagement sequence is to recognize the type of aircraft. Types of aircraft of most concern to the FAAD gunner include fighters, fighter-bombers, attack, light transports, light aircraft, and helicopters. The correct solution to the FAAD gunnery problem depends to a great extent on the gunner's knowledge of aircraft characteristics. The gunner must be able to differentiate between enemy and friendly aircraft that operate over the area of Redeye employment. Aircraft of potential enemy and friendly forces have many identical features. Each gunner must be able to recognize aircraft types and know how to estimate their approximate dimensions. A small error in estimating wingspan or fuselage length is not critical but a large error could result in missing the target completely. With high-speed targets, the gunner's evaluation of aircraft dimensions must be made rapidly while engaging the target. When FAAD gunners

are using the tracking head trainer during tracking and simulated engagement exercises, actual aircraft should be employed to give gunners as much practice as possible in tracking different types of aircraft.

b. Aircraft Characteristics.--The gunner must know the general dimensions of an aircraft to enable him to estimate range. This does not imply that the gunner must remember a mass of data concerning each aircraft. Knowing the approximate length of wingspan is much more useful information, for example, than knowing the weight or cargo capacity of aircraft. The vital information about an aircraft for use by the gunner includes wingspan in meters, fuselage length in meters, approximate normal operating speed (knots/meters per second), and type of engine(s) (jet or reciprocating).

(1) Aircraft Dimensions.--The overall dimensions of an aircraft are directly related to target ranging. The dimensions of a fixed-wing aircraft include wingspan and fuselage length. The dimensions of a helicopter are cabin width and fuselage length. The dimensions which are normally measured in feet and inches have been converted to meters and rounded off for use by the Redeye gunner to simplify target ranging. The length of the fuselage or wingspan, as related to the sight picture seen by the gunner in the range ring, helps him determine the range to the target. Aircraft dimensions are further grouped into specific categories for solving gunner ranging and are described later in this chapter.

(2) Aircraft Speed.--The gunner's knowledge of the speed of general types of

aircraft will assist him during an engagement. By making a fair estimate of the aircraft's speed, he can readily determine whether it is within the Redeye weapon capabilities. While the gunner may not be able to estimate the approximate speed that an aircraft is flying, he should attempt to identify the aircraft type, jet or nonjet. In most cases, an error in speed estimate is not critical because gunner firing criteria has been optimized to compensate for error in speed estimates. During close support of ground operations, most aircraft fly at a speed of not more than 450 knots and at altitudes ranging from several hundred to several thousand feet. A typical jet attack aircraft, when effectively delivering its ordnance, has a ground attack speed between 300 and 450 knots. The attack speed of a jet aircraft during close-in ground support is a function of aircraft characteristics. Speeds of aircraft are further grouped into specific categories to ease the gunner ranging problem. A nonjet aircraft which is in a low-medium performance category has a speed of 0-300 knots. A jet aircraft falls into the high performance class of above 300 knots. An easy way to convert knots to approximate meters per second is to divide the speed in knots by two. For example, a 100-knot target is flying at a speed of approximately 50 meters per second.

(3) Type of Engine.--Engine type information is useful to the gunner during an engagement because the type of engine affects infrared acquisition. Most propeller aircraft can be acquired in a head-on aspect, but jet aircraft IR radiation is masked and requires the gunner to wait until the aircraft

is in a crossing or outgoing aspect. Some propeller aircraft and helicopters have the engine exhaust on only one side of the aircraft. When the aircraft is flying on a crossing course, the IR radiation source may be on the opposite side of the aircraft from the gunner's position, thereby reducing the probability of IR acquisition until the aircraft is close in. The exhaust may be shielded momentarily when the aircraft banks for a turn.

(4) Categories of Aircraft.--Aircraft against which Redeye may be employed have been separated into two categories based on their speed and IR radiation characteristics. These categories are low-medium performance aircraft and high performance aircraft.

(a) Low-Medium Performance Aircraft.--This category consists primarily of observation and reconnaissance propeller aircraft and helicopters.

1 Small Propeller Aircraft.--Small propeller aircraft (see fig. 30)

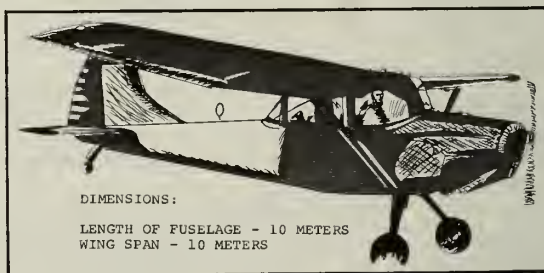


Figure 30.--Typical Low-Performance Liaison-Observation Aircraft.

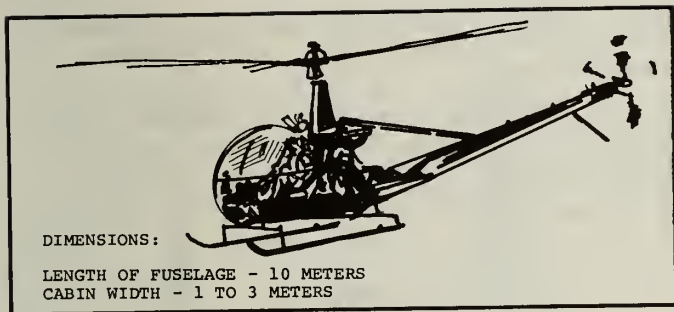


Figure 31.--Typical Light Helicopter.

have a 10-meter wingspan and a 10-meter fuselage length.

2 Helicopters.--Small helicopters (see fig. 31) have a 1- to 3-meter cabin (bubble) width and a 10-meter fuselage

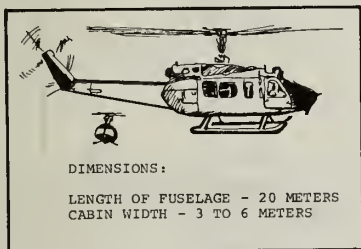


Figure 32.--Typical Medium Helicopter.

length. Large helicopters (see fig. 32) have a 3- to 6-meter cabin width and a 20-meter fuselage length.

3 Other Aircraft.--Also in the low-medium category are propeller driven transports and cargo aircraft which would not often be engaged by FAAD gunners. Representative aircraft (see fig. 33) have a wingspan of 30 meters and a fuselage length of 25 meters.

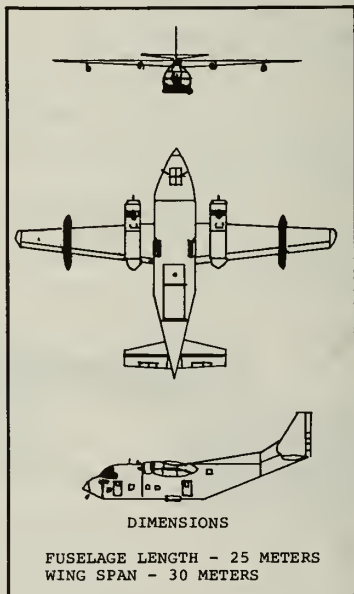


Figure 33.--Typical Light Transport.

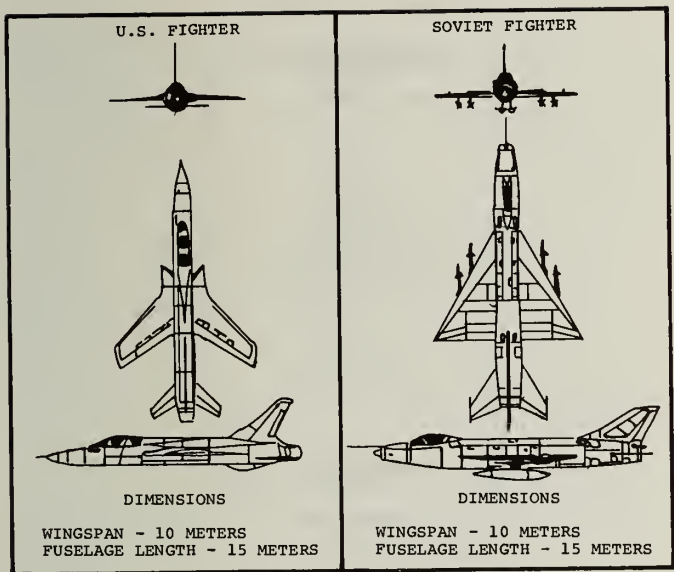


Figure 34.--Typical Jet Fighters.

(b) High-Performance Aircraft.

--This category consists of all fighter and attack jet aircraft (see figs. 34 and 35). The small jet aircraft has a 10-meter wingspan and a 15-meter fuselage length. The larger jet aircraft has a 25-meter wingspan and a 30-meter fuselage length.

c. Aircraft Recognition.--At the earliest possible time in the engagement sequence, the FAAD team leader must visually

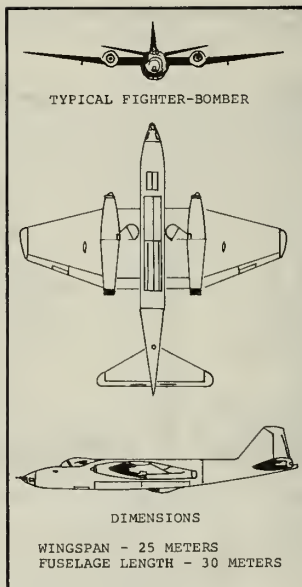


Figure 35.--Typical Fighter-Bomber.

distinguish between (or confirm identification of) friendly and enemy aircraft. When the FAAD team members are acting independently of each other, both members must identify aircraft independently. High speed, low-flying aircraft are difficult to identify, especially if friendly and enemy jets have similar silhouettes. Light reconnaissance aircraft (helicopters and propeller driven)

fly slower, but may also have similar silhouettes and be difficult to identify. Target identification must always be viewed as a continuing process. Immediately upon detecting the aircraft, the FAAD gunner should make a preliminary (tentative) aircraft identification. When the tentative identification is hostile, the gunner should proceed with the engagement sequence to include weapon warmup, particularly in the case of high-performance aircraft. In every case, the gunner should proceed to establish track and only abandon track on a positive identification of friendly. If this tentative identification is friendly, the gunner continues to observe the aircraft to resolve any doubt, while ensuring other aircraft are not allowed to pass undetected during this time. Since rules for engagement require a visual, positive, hostile identification be made before the gunner fires, tentative, hostile identification will be further verified or changed, as necessary, prior to the moment of firing. If the identification as hostile is not positive, the rules for engagement normally require that the gunner hold fire.

d. Total Form Concept.--Success in aircraft recognition depends upon a knowledge of aircraft appearances. Recognition of aircraft by all external features is referred to as the "total form" concept. This can be achieved only by continued study augmented by a number of training aids available for this purpose. Aircraft must be studied from the standpoint of recognizing the distinguishing features of their particular shapes; however, two problems must be avoided.

(1) Minor details of aircraft should not be emphasized because they are not likely to be visible at long ranges.

(2) In analyzing an aircraft part by part, care must be taken not to lose sight of its overall configuration, or "total form." Each element should be examined, not as a recognition feature in itself, but as an integral part of the aircraft's general design.

e. Special Considerations

(1) Recognition skill is acquired only with practice. Gunners are never trained to the extent that further study is no longer needed. Constant review is essential as long as a requirement for aircraft recognition exists.

(2) FAAD gunners must have a minimum 20-20 vision (corrected) and a hearing loss no greater than 15 decibels between 500 and 2000 (Hz), or 40 decibels at 4000 (Hz).

(3) Aircraft recognition study is important because the FAAD gunner cannot rely on electronic means to identify aircraft, but must be able to visually recognize an aircraft as friendly or hostile and react accordingly.

(4) Supplementary methods for visual recognition of aircraft include:

(a) Use of binoculars.

(b) Use of early warning (radio).

(c) Recognition by several observers.

(d) Corridor immunity.

(5) During FAAD training, the gunner is introduced to the procedures of aircraft recognition. The FAAD gunner must

continue aircraft recognition training in the particular area where assigned in order to achieve and maintain maximum proficiency.

2304. INFRARED RADIATION ACQUISITION OF TARGETS

a. General.--In the Redeye engagement sequence, IR acquisition of the target by the seeker is essential for a successful engagement. Redeye engagement requires the gunner to have a knowledge of target characteristics, including IR radiation, so he can decide when to activate the weapon, acquire, and fire.

b. Infrared Acquisition Boundaries.--The target must be within seeker acquisition range. The acquisition boundary of the weapon is the point at which the target IR radiation is strong enough for the seeker to track the target. The target range at which acquisition is accomplished varies with the target radiation pattern, atmospheric conditions, and background radiation.

(1) Target Radiation Pattern.--A target radiation pattern is an outline of a constant level of IR radiation intensity. Figures 36 and 37 show the radiation patterns of two typical Redeye targets, a single-engine jet aircraft and a helicopter. IR radiation emanating from an aircraft has many sources, but the primary source is the hot metal parts of the engine exhaust system.

(a) The jet aircraft shown in figure 36 produces a radiation intensity that is strongest from a rear aspect and becomes weak as the nose aspect is approached, because

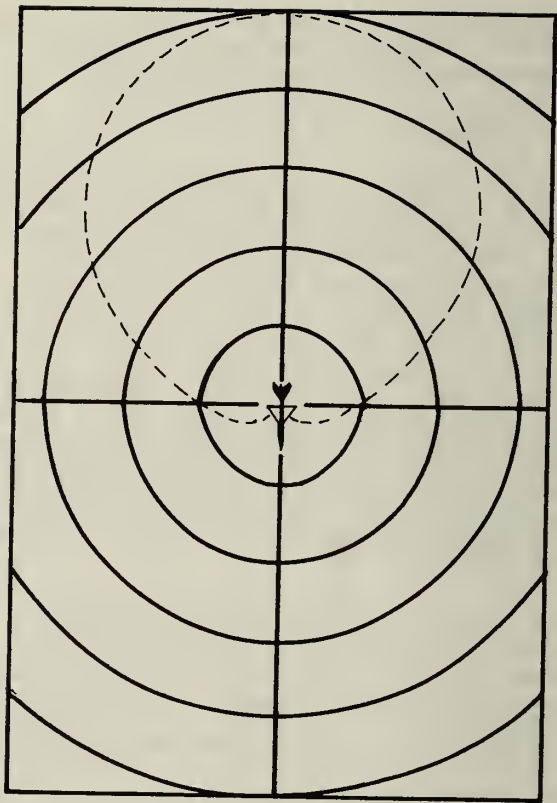


Figure 36.--Radial Pattern of Typical Jet Fighter.

the exhaust is directly to the rear of the aircraft. Because of the shape of the radiation pattern of a jet aircraft, IR acquisition may occur just prior to crossover for some jet aircraft and just at crossover or beyond for other jet aircraft.

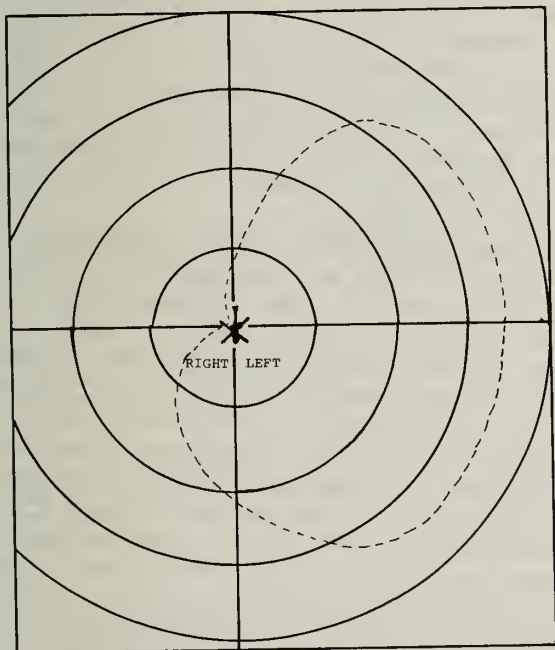


Figure 37.--Radial Pattern of Typical Helicopter With Exhaust on Left Side.

(b) The helicopter shown in figure 37 has a front-mounted engine and the pattern is based on an exhaust directed toward the left rear. Shielding of the source of radiation by the aircraft's fuselage, interior firewalls, and engine mounts permit very little radiation from the right side of the craft. However, this particular engine exhausts produces strong radiations from the front, left side, and left rear of the helicopter. Helicopters with top mounted rear exhaust engines produce a radiation pattern similar to that of jet aircraft. The radiation patterns of each type of aircraft differ, but in general, are strongest in aspects where the exhaust is viewed most directly.

(2) Missile Infrared Radiation Seeker Sensitivity.--The missile detects a target by optically focusing target IR radiations on the surface of an IR detector in the missile seeker system. The detector cell changes its electrical characteristics in the presence of IR radiation; the amount of change depends on the strength of the IR radiation received. The temperature of the cell determines the minimum signal strength that can be detected. The optimum detector cell sensitivity occurs at approximately minus 100 degrees Fahrenheit. Detection occurs whenever the IR radiation signal changes the electrical characteristics of the cell enough to activate the seeker circuits.

(3) Atmospheric Limitations.--The atmosphere is not completely transparent to IR radiations. Certain gases in the atmosphere, primarily carbon dioxide and water vapor, absorb energy in the IR radiation frequency spectrum. Because the amount of carbon

dioxide in the air is fairly constant, its effect on detection range is constant and need not be considered by the gunner. Water vapor, however, varies widely with geographic location and local weather conditions and can adversely affect Redeye engagement capabilities. In general, the higher the humidity, the shorter the range of IR radiation acquisition. Other particles in the atmosphere, such as dust, smoke, fog, and rain, will absorb and scatter IR radiations and reduce IR acquisition ranges.

(4) Background Radiations.--All objects emit some degree of energy in the IR radiation frequency spectrum. The sun is an extremely strong source of IR radiation and must be avoided when firing the Redeye weapon. If the sun's direct rays enter the field of view of the seeker, it will track the sun rather than the target. The sun's IR radiation is also reflected from objects, causing these objects to become secondary sources of background radiation. Typical secondary sources are bodies of water, bare hillsides, and white clouds. Some sources of secondary background radiation are shown in figure 38. The Redeye IR radiation seeker can discriminate between radiations from small point sources, such as the tailpipe of a jet, and large background sources, such as clouds and terrain. With the exception of the sun, the hot metal parts of the engine exhaust system of the target are usually the smallest and hottest objects in the environment and, therefore can be acquired and tracked by the missile seeker.

2305. RANGE TECHNIQUES AND RANGE RING PROFILES

Two important procedures in using the

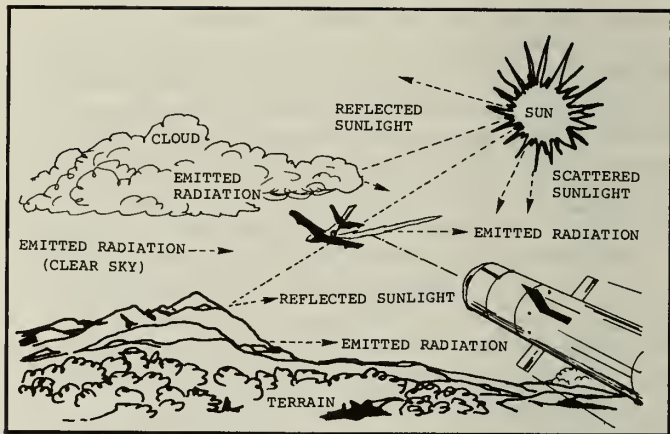


Figure 38.--Background Radiations.

Redeye weapon are proper use of the sight and estimation of the target range. Proper use of the sight requires practice. Range estimation requires a knowledge of aircraft sizes, and distance-size relationships, using the sight. Target ranging is accomplished by the use of the range ring located within the sight.

a. Sight Description

(1) Launcher Sight.--The launcher sight is used to aid the gunner in acquiring and ranging the target. In addition, the sight provides a means of introducing super-elevation (and lead if required).

(2) Sight Reticle.--The open sight of the Redeye weapon, as viewed by the gunner

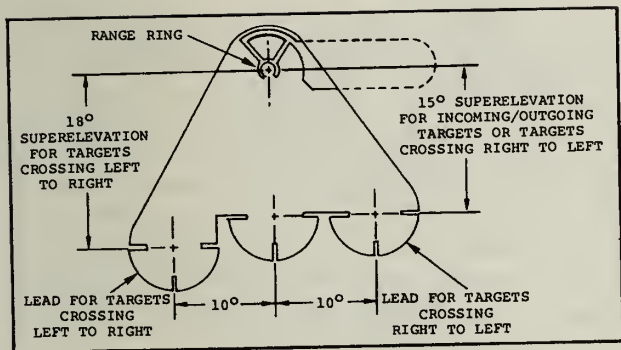


Figure 39.--Diagram of Open Sight Assembly (M41E2).

(see fig. 39), consists of a front range ring, a middle aperture with three semicircular openings below, and a rear peepsight. The peepsight is located at the rear of the sight and used by the gunner to properly align the other elements. The small range ring is located at the forward end of the sight and used by the gunner to estimate the range of a target. The three semicircular rings provide for insertion of superelevation and lead angle.

(3) Range Ring.--Within the gunner's field of view, the range ring is 10 mils in diameter and has a notch 2.5 mils wide at the bottom. The range ring is boresighted so the caged missile seeker will be centered on the target that the gunner is visually tracking. The range ring is used by the gunner to align the launch tube directly with the target as well as to determine target range.

b. Target Ranging.--The Redeye firing decision depends on the gunner determining when the target is within the effective launch zone of the missile. This decision requires a knowledge of the type of target being engaged and the ability to range the target. The Redeye sight pattern can be used in determining target range. Ranging with the Redeye sight is performed by measuring the size of the target in relation to the sight range ring. When the target image is superimposed on the sight range ring, the target image size will change as the range to the target increases or decreases. The target size as seen by the gunner through the range ring is, therefore, related to target range. The gunner forms a mental profile of the various representative low-medium and high performance aircraft and applies these profiles to the range ring to solve ranging problems.

(1) Use of the Range Ring Profiles.

--The target width as seen through the range ring is expressed as one-half range ring diameter, one-third range ring diameter, etc. The Redeye gunner need only determine the space the target image covers in the range ring. A target image will appear greater than the diameter of the range ring as range to the target decreases. This can be expressed as twice the range ring diameter or three times the range ring diameter. Example of two types of helicopters at various ranges and a high performance jet aircraft are shown in figures 40 and 41.

(2) Maps and Range Cards.--A military map can be used for determining distance. The map is used to plot distances to various

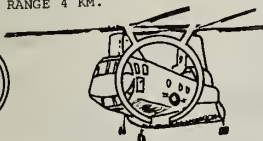
1. ONE-HALF RANGE RING
DIAMETER, RANGE 4 KM.



3. THREE-FOURTHS RANGE
RING DIAMETER, RANGE
2.7 KM.



2. TWO TIMES RANGE RING
DIAMETER, RANGE 1 KM.



4. FOUR TIMES RANGE RING
DIAMETER, RANGE 0.5 KM.

A

1. ONE-THIRD RANGE RING
DIAMETER, RANGE 3.0 KM.



3. RANGE RING DIAMETER,
RANGE 1 KM.



2. TWO TIMES RANGE RING
DIAMETER, RANGE 0.5 KM.



4. ONE-THIRD RANGE RING
DIAMETER, RANGE 3.0 KM.

B

Figure 40.--Range Ring and Target
Profile of Helicopters.



1. THREE-FOURTH RANGE RING
DIAMETER, RANGE 4 KM.



2. RANGE RING DIAMETER,
RANGE 3 KM.



3. THREE TIMES RANGE RING
DIAMETER, RANGE 1 KM.



4. RANGE RING DIAMETER,
RANGE 3 KM.



5. THREE TIMES RANGE RING
DIAMETER, RANGE 1 KM.

Figure 41.--Range Ring and Target Profiles
of Attack Bomber.

landmarks or terrain features. When team personnel are oriented with a military map and know approximate distances to various landmarks, it is a simple matter to construct a range card. (See fig. 42.) The purpose of the range card is to enable the FAAD gunner to have a ready reference to various ranges within view of the position. By knowing the capabilities and limitations of the weapon and the ranges of various landmarks and objects, the gunner can readily determine if a target

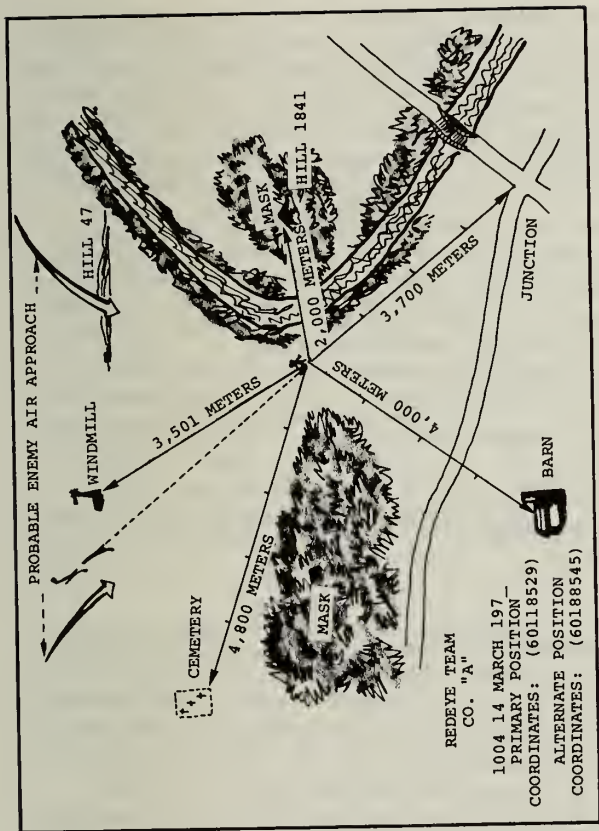


Figure 42.--Typical Range Card.

can be engaged. Targets to be engaged by Red-eye teams generally will be operating at low altitudes. Accordingly, the slant range (line of sight distance) to these targets will be only slightly greater than the horizontal range (the distance to a point in the horizontal plane directly below the target). This difference is not considered consequential.

(3) Other Ranging Aids.--Other aids for estimating ground distance to distant objects are binoculars, Redeye weapon long ring, and the gunner's hand. These aids are used to supplement data more easily obtained from maps when maps are not available. The gunner may sight an object with binoculars or through the range ring of the weapon and, by using the range ring profiles previously described, find the range of specific landmarks or temporary objects located on the ground within view of the position. The use of the hand, fingers, or thumb may also be used to estimate range. FM 6-135, Adjustment of Artillery Fire by the Combat Soldier, describes the process.

2306. CONDUCT OF FIRE

a. General.--The gunner must know the general target characteristics and the best weapon employment techniques to maximize effectiveness of the Redeye weapon. This section discusses gunner techniques of fire combined with the functional steps of weapon firing procedure, factors which govern the gunner's decision to activate the weapon, hold fire, resume fire, and cease fire. The information contained in target detection and search and scan procedures explained how the gunner visually detected the target and infrared

acquisition explained how the target was acquired. Ranging techniques explained how, if the target is hostile, the gunner ranges to determine whether it can be engaged or not. The gunner must study the material in this section and the material in FM 23-17A, Redeye Guided Missile System (U), to gain and maintain an understanding of Redeye employment techniques.

(1) Gunner Skills.--Gunner skills are directly related to training and are developed and measured in the following areas:

(a) Identification and recognition of aircraft by visual means.

(b) Evaluation of the threat and engagement probability in consideration of the target, type, path, speed, range, and IR radiation characteristics.

(c) Preparation of the weapon for firing.

(d) Determination of the area in which aircraft can be acquired by the Redeye weapon based upon target IR radiation characteristics, speed, course, aspect, and weapon seeker capabilities.

(e) Positioning the weapon to the estimated acquisition area, ranging, and electrically energizing (warmup) the weapon at the proper time. The warmup time decision considers the limited launcher BCU life, the time of entry of the target into the acquisition zone, and the time until the missile can be launched.

(f) Acquisition of the target after entry into the probable acquisition zone by pointing the weapon so that the sight range ring is held on the target. The tone from the audio acquisition indicator is used

to determine if IR radiations from the target are being received.

(g) Uncaging switch activation followed by ensuring the seeker is tracking the target by listening to the changed audible tone output from the weapon.

(h) Alternate procedures if IR radiation is lost between uncage and activation of the fire trigger which involves recaging and attempting to reacquire the target.

(i) Determination of requirement to lead the target and direction of lead based on target course, speed, and range. Insertion of superelevation (and lead angle in the correct direction if required).

(j) Determination of optimum firing time to ensure maximum probability of an effective engagement.

(k) Activation of the firing trigger at the proper time and holding the trigger and maintaining superelevation and lead until launch while maintaining track (follow-thru).

(2) Activate.--The "activate" zone encompasses the entire area within which the target may be when the gunner should activate the weapon. The determination of the "activate" zone is very important in technique of fire on all targets. A high-speed target will be in the launch zone for a short period of time and the activation zone has been established to allow weapon warmup prior to launch. For specific explanation of "activate" zones, see FM 23-17A, Redeye Guided Missile System (U). The gunner is able to determine the activation zone for a specific target engagement after determination of target track and

track type. The gunner must activate the weapon at least 3 to 5 seconds before the target comes within IR acquisition range. When preparing to engage a low-medium or high performance target, the gunner will activate the weapon as soon as he determines the target is within the activation zone. If the BCU life is exceeded, he may still continue the engagement by inserting a new BCU in the weapon.

(3) Launch.--The missile launch zone defines the volume of space within which the target may be successfully engaged. The target must be within the launch zone defined by the missile performance boundaries, and positive IR acquisition must be achieved. The size and shape of the launch zones and their location with respect to the gunner will vary with target speed and altitude. Launch for low-medium performance aircraft may take place as soon as the target is within the determined launch limits and IR acquisition has occurred. If the low-medium performance target is within the launch zone and IR acquisition has not occurred prior to the end of the BCU life, the gunner must use another BCU. The optimum time for missile launch for high-performance aircraft is a function of crossover point and IR acquisition. If IR acquisition occurs prior to crossover, the gunner will uncage the gyro, insert superelevation (and lead if required), and fire in accordance with the applicable engagement procedures for an incoming-overhead target. If IR acquisition occurs after crossover, the gunner will then perform the firing sequence as quickly as possible. The gunner's determination as to when to hold fire and resume fire are functions of weapon capabilities and limitations and are

described in the techniques of fire rules found in FM 23-17A, Redeye Guided Missile System (U).

(4) Cease Fire.--At the point along the aircraft course when the gunner estimates the target to be outside the launch zone, he must cease fire. This estimate is based on the gunner's ability to range the target with the Redeye weapon sight.

b. Firing Technique for Engaging Low-Medium Performance Targets

(1) Typical Low-Medium Performance Characteristics.--The identifying characteristics of typical low-medium performance aircraft are as depicted in figure 43.

(2) Technique of Fire Rules.--For engagement of this type of target, the gunner may refer to technique of fire rules and performance capability as described in FM 23-17A, Redeye Guided Missile System (U).

(3) Engagement Sequence.--Figure 44 shows the sequence of events in the engagement of a low-medium performance target. The engagement should proceed as follows:

(a) Visual Detection.--The gunner searches and scans for aircraft. When the aircraft is detected, gunner visually tracks the aircraft and readies the weapon.

(b) Determination of Aircraft and Track Type.--Gunner classifies aircraft by performance type and track. Target track type is determined to be incoming-crossing, outgoing-crossing, incoming-overhead, or outgoing-overhead.

(c) Acquisition of Target in Sight Range Ring.--Gunner shoulders the weapon,

points it in the direction of the target, and usually acquires the target in the sight range ring. He begins tracking and ranging

DIMENSIONS

1. Propeller (Small):

Wingspan 10 meters
Length of fuselage 10 meters

2. Propeller (Large):

Wingspan 30 meters
Length of fuselage 25 meters

3. Helicopter (Small):

Cabin width 1-3 meters
Length of fuselage 10 meters

4. Helicopter (Large):

Cabin width 3-6 meters
Length of fuselage 20 meters

CRUISING SPEED

0-300 knots

IR CHARACTERISTICS

Incoming, outgoing, and crossing.

Figure 43.--Dimensions and Characteristics of Typical Low-Medium Performance Aircraft.

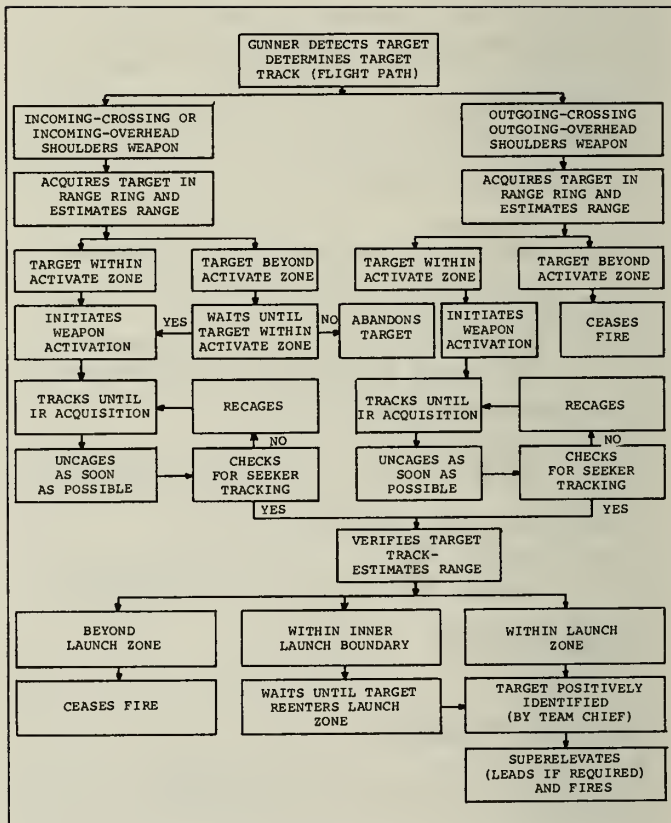


Figure 44.--Engagement Procedures for Low-Medium Performance Target.

the target (using the methods described in target ranging and the criteria specified in FM 23-17A, Redeye Guided Missile System (U)) to determine target position in relation to the activation zone. When an incoming target is estimated to be beyond the activation zone, the gunner waits until the target is within the activation zone to activate the weapon. When the target is outgoing beyond the activation zone, the gunner does not activate the weapon.

(d) Activation.--The gunner activates the weapon when the target is estimated to be within the activation zone. Most low-medium performance aircraft have IR radiation characteristics which allow the gunner to acquire them from both an incoming and outgoing aspect. The gunner must recall the range ring profile of the specific type (large-small) target in relation to the activation zone. When the gunner activates the weapon, it takes it approximately 3 to 5 seconds to warm up. During warmup, the gunner continues to track the target in the range ring.

(e) IR Acquisition.--The weapon is capable of detecting IR radiation 3 to 5 seconds after activation. The gunner tracks the target in the range ring with the gyro in the caged condition until IR acquisition is achieved. When this occurs, he uncages the gyro as soon as possible by pressing and holding the uncaging switch. The gunner ensures the seeker is tracking and, if the audible tone is good, continues to track the target. If seeker tracking is not obtained or is lost, the gunner releases the uncaging switch which recages the gyro and continues to track the target. When IR

acquisition is again attained, he uncages and checks for seeker tracking.

(f) Verification of Target Track.--The gunner verifies the latest target direction to determine whether the target is on the same course or has altered its initial course.

(g) Range Estimation, Incoming.--If the aircraft is incoming and the gunner determines that it is in the launch zone, he proceeds with the engagement firing sequence. If the gunner determines it is outside the launch zone and inside the inner launch boundary, he waits until the target passes the inner launch boundary and enters the launch zone and then proceeds with the firing sequence.

(h) Range Estimation, Outgoing.--If the aircraft is outgoing and the gunner determines that it is in the launch zone, he proceeds with the engagement firing sequence. If the gunner determines the target is inside the inner launch boundary, he waits until the target reenters the launch zone and continues the firing sequence. If the gunner determines the outgoing target is beyond the launch zone, he ceases the engagement.

(i) Positive Identification.--The team leader positively identifies the aircraft as hostile and notifies the gunner. Final positive identification must take place prior to the firing stage.

(j) Superelevation, Lead, and Fire.--When the gunner determines that the target is within the launch zone, he uncages and inserts superelevation (and lead if required). If the acquisition tone is good, the gunner presses and holds the firing trigger

until after missile ejection, ensuring that he continues to track the target (follow-thru).

c. Firing Technique for Engaging a High-Performance Target

(1) Typical High-Performance Aircraft Characteristics.--The identifying characteristics of a typical high-performance aircraft are as depicted in figure 45.

(2) Technique of Fire Rules.--For engagement of this type of target, the gunner may refer to detailed technique of fire rules,

DIMENSIONS

1. Small Jet Aircraft:

Wingspan 10 meters
Length of fuselage 15 meters

2. Large Jet Aircraft:

Wingspan 25 meters
Length of fuselage 30 meters

GROUND ATTACK SPEED DURING CLOSE-IN GROUND SUPPORT

About 300 knots (150 meters per second)

IR CHARACTERISTICS

Incoming-crossing and outgoing.

Figure 45.--Dimensions and Characteristics of Typical High-Performance Aircraft.

performance capabilities; range ring, and target profiles, illustrated in FM 23-17A, Redeye Guided Missile System (U).

(3) Engagement Sequence.--Figure 46 shows the sequence of engagement of a high-performance target. The incoming-crossing, outgoing-crossing, and outgoing-overhead target engagement should proceed as follows:

(a) Visual Detection.--The gunner searches and scans for aircraft. When the aircraft is detected, the gunner visually tracks the aircraft. The weapon should be readied prior to engagement as described in section 4 of this chapter.

(b) Determination of Aircraft and Track Type.--The gunner classifies the aircraft by performance type and track. Target track is determined to be incoming-crossing, outgoing-crossing, incoming-overhead, or outgoing-overhead. The gunner makes an estimate of target track to determine the cross-over line prior to tracking the target and applies the right angle fire delay rule, if applicable. An engagement procedure for engaging incoming-overhead targets is described below.

(c) Acquisition of Target in Sight Range Ring.--The gunner shoulders the weapon, points it in the direction of the target, and visually acquires the target in the range ring. He begins tracking and ranging the target to determine target range in relation to the activation zone. When an outgoing-crossing or outgoing-overhead target is estimated to be beyond the incoming activation zone, the gunner waits for the target to be in the incoming activation zone. When an outgoing-crossing target is estimated to be

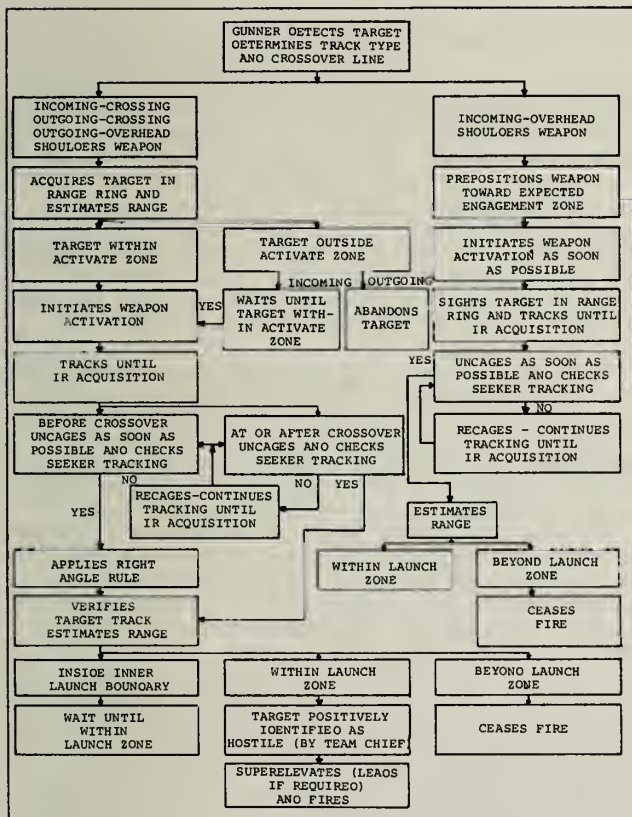


Figure 46.--Engagement Procedures for High-Performance Target.

outside the outgoing activation zone, the gunner does not activate the weapon.

(d) Activation.--The gunner activates the weapon when the target is estimated to be within the activation zone. This allows the weapon sufficient warmup time to enable the weapon to acquire the target prior to crossover, if sufficient IR energy is radiated from the target. During warmup, the gunner continues to track the target in the range ring. The gunner must recall the range ring profile on the specific type target in relation to the activation zone so that he can estimate when the target is within the "activate" zone.

(e) IR Acquisition.--When the target has not passed the crossover point and IR radiation is acquired, the gunner uncages the gyro as soon as possible. The gunner checks seeker tracking and, if the audible tone is good, continues to track the target. When seeker tracking is not obtained or is lost (audible tone is not good), the gunner releases the "uncage" switch, reestablishes tracking, and repeats the sequence, until IR radiation is acquired. This procedure is valid prior to and after target reaches the crossover point.

(f) Verification of Target Track.--The gunner applies the right angle rule (see FM 23-17A, Redeye Guided Missile Missile System (U)) and determines whether the target is on the same course or has altered its initial course. If the target track has changed, the gunner must then use the engagement procedures applicable to the new target track. (See fig. 46.)

(g) Range Estimation.--Range

estimation procedures are the same as for low-medium performance aircraft.

(h) Positive Identification.--The team leader positively identifies the aircraft as hostile and notifies the gunner. Final positive identification must take place prior to the firing stage.

(i) Superelevation, Lead, and Fire.--As soon as the gunner determines the target is within the launch zone and the target has been positively identified as hostile, he inserts superelevation (and lead as required). If the acquisition tone is good, the gunner presses and holds the firing trigger, continues to track the target until after the missile ejects. The gunner must ensure he follows through with the target track until after missile ejection.

(4) Engagement Sequence (Incoming-Overhead Target Track).--In a typical engagement of a high-performance target on an incoming-overhead target track, the target will be engaged on its outgoing course after it has passed close to (within 500 meters) or over the gunner's position. This engagement (see fig. 47) should proceed as follows:

(a) Visual Detection.--When the aircraft is detected, the gunner visually tracks aircraft and tentative identification of aircraft as hostile is made by the team leader.

(b) Determination of Aircraft and Type of Track.--The gunner determines the aircraft to be a jet. He also determines the size of aircraft as to whether it is large or small. Target track is determined to be incoming-overhead.

(c) Preposition.--While

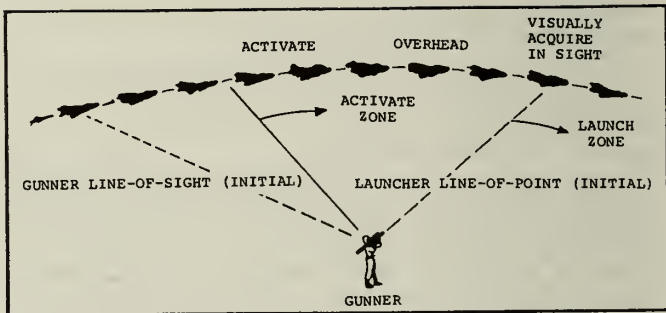


Figure 47.--Preposition Technique for Incoming-Overhead High-Performance Target.

visually tracking the target (without using the sight), the gunner shoulders the weapon. For incoming-overhead targets (i.e., targets within 500 meters of gunner's position or directly overhead), the gunner should not attempt to track the incoming target with the sight. For this type of target, the gunner should aim the weapon in the outgoing direction toward the anticipated launch zone (see fig. 47).

(d) Activation.--The gunner initiates warmup as soon as possible after prepositioning.

(e) IR Acquisition.--As the incoming-overhead target passes beyond the crossover point or over the gunner's position, the gunner establishes weapon track. The gunner tracks the target in the sight range ring with the gyro in caged position until IR radiation is acquired. When IR acquisition is achieved, the gunner uncages the gyro. If

seeker tracking is lost, the gunner recages the gyro, continues to track the target until IR radiation is reacquired, and uncages the gyro again.

(f) Range Estimation.--The gunner determines whether the target is inside or outside the launch zone. If target range is determined to be greater than effective launch range, he ceases engagement. When the gunner determines the target is within effective range, he proceeds with the firing sequence.

(g) Positive Identification.--The team leader positively identifies the aircraft as hostile and notifies the gunner. Final positive identification must take place prior to the firing stage.

(h) Superelevation, Lead, and Fire.--When the gunner determines the target is within the launch zone, he inserts superelevation (and lead as required). If the seeker tracking tone is good, the gunner presses and holds the firing trigger and continues to track (follow-thru) until after missile ejection.

d. Multiple Targets.--During attacks by multiple aircraft, the team leader coordinates the fire of both team members to ensure that the greatest threat is engaged first. During multiple aircraft attacks, the team leader and the gunner initiate and continue the identification process throughout the engagement.

Section IV. FIRING PROCEDURES

2401. INTRODUCTION

A complete, smoothly executed firing sequence is an absolute requirement in the use of the Redeye missile system. The gunner must know the firing sequence and perform it automatically to be successful. Operation of the weapon consists essentially of:

- a. Removing the cap assembly and receptacle cap and inserting the BCU in the launcher.
- b. Commencing visual tracking and ranging.
- c. Activating the weapon when the target enters the activation zone by operating and releasing the safety and actuator device and continuing to track.
- d. Acquiring the target.
- e. Uncaging the gyro.
- f. Applying superelevation (and lead as required).
- g. Pressing and holding the firing trigger.
- h. Continuing to track.

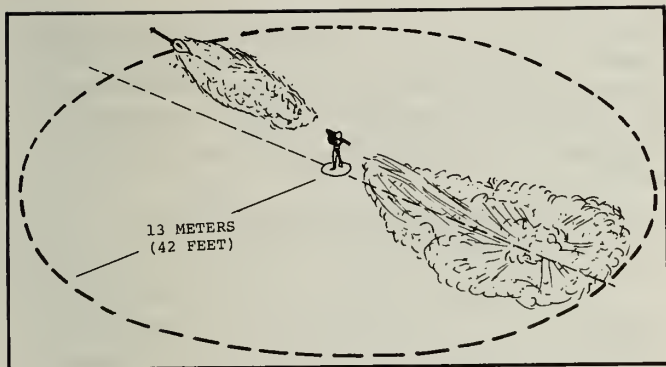


Figure 48.--Firing Area Safety Diagram.

2402. FIRING INSTRUCTIONS

a. Precautions Prior to Firing.--Safety precautions which the gunner must observe prior to firing are:

(1) Ensure that the launcher area is clear of personnel and equipment for a radius of at least 13 meters behind the weapon (see fig. 48). If team members are separated by less than 13 meters in a tactical situation, the gunner not engaging the target is responsible for staying outside the weapon backblast hazard area.

(2) Never fire with launcher elevated more than 65 degrees (after superelevation is applied).

(3) Do not fire from a kneeling or prone position; fire from a standing position only.

(4) A plastic eyeshield attached to

the weapon and the sight reticle afford eye protection during firing. In nontactical firings, helmet, flak jacket, and ear protection devices are mandatory. The following paragraphs explain the step-by-step procedures that the gunner follows in firing the Redeye weapon. The exact sequence of steps may vary with the tactical situation.

2403. BCU RECEPTACLE CAP REMOVAL AND REPLACEMENT

The Redeye weapon is shipped with a receptacle cap in the launcher BCU receptacle to keep the launcher electronic contacts clean. The cap should be kept in place until a BCU is inserted. Remove the receptacle cap by twisting it counterclockwise; replace by reversing this procedure.

2404. VISUAL TRACKING AND TARGET RANGING

The gunner visually tracks the target and determines if it is within range of the weapon. Range to the target is estimated, using the sight range ring inside the sight assembly. (See fig. 39.) A detailed explanation of range estimation (target ranging) is provided in section 3 of this chapter.

2405. WEAPON ACTIVATION AND WARMUP

The gunner presses the safety and actuator device which activates the BCU for launcher power. It takes approximately 3 to 5 seconds for the weapon to warm up. The location of the activation zone varies with the type of target, its velocity, and its flight path.

2406. TARGET ACQUISITION

When the gunner positions the sight so that the target appears in the center of the range ring, an audible and vibrating signal provides an indication that the missile seeker has acquired a target. If the target is within effective range and steady target acquisition signals are received, the gunner proceeds with the firing sequence. Two conditions must be present for the missile seeker to acquire target infrared radiation:

a. The weapon must be activated and pointed at the target.

b. The infrared radiation from the target must be sufficiently strong.

2407. UNCAGING SWITCH

The seeker, when caged, is aligned with the sight range ring for target acquisition and must be released to automatically track a moving target before superelevation (and lead if required) is inserted. The uncaging switch uncages the gyro. The uncaging switch will not be activated until after the missile seeker has acquired the target. When uncaged and tracking, a distinct seeker-tracking sound is normally audible. The uncaging switch also acts as a safety interlock to prevent the missile from being fired until both the uncaging switch and firing trigger are activated.

2408. SUPERELEVATION AND LEAD

a. Superelevation is introduced to

compensate for missile tipoff, caused by gravity during the period between missile ejection and sustainer ignition. Lead must be inserted for all crossing targets to minimize missile maneuver.

(1) With the gyro uncaged and the seeker tracking the target, the gunner positions the target image in one of the three lower semicircles under the range ring to introduce superelevation, and lead if required. Superelevation and lead help to establish a missile attitude that is more nearly on the line of sight to the target after missile launch, and prevents the missile from impacting the ground when fired at low-flying targets.

(2) For crossing targets, the gunner inserts 10 degrees lead to reduce the initial missile maneuver required for target interception. For a target crossing from left to right, the gunner positions the launcher so as to center the target in the lower left semicircle of the sight. For a target crossing from right to left, the gunner centers the target image in the lower right-hand semicircle of the sight. The target must always appear to fly toward the middle superelevation ring after superelevation has been inserted, never away from it. No lead is required for straight incoming or outgoing targets. For these targets, the gunner centers the target image in the middle circle of the three lower semicircles of the sight.

(3) The right and center semicircular positions (see fig. 39) allow the gunner to superelevate the weapon 15 degrees. The left position, used for left to right crossing targets, allows the gunner to superelevate the weapon 18 degrees. Precise centering of the

target is not necessary.

2409. INTERRUPTING THE FIRING SEQUENCE

a. Since the normal life of the BCU is at least 30 seconds, the firing sequence may be interrupted for reacquisition of the target after the safety and actuator device has been pressed, if the firing trigger has not been pressed within this time period. The gunner then replaces the BCU before engaging another target. If the Redeye weapon is not to be used again, the receptacle cap and cover are replaced.

b. After the gyro is uncaged, and the audible acquisition signal is lost, the uncaging switch is released and the gunner attempts to reacquire the target.

2410. FIRING TRIGGER

With the uncaging switch held down, pressing and holding the firing trigger activates the thermal battery and the delay circuit in the missile. The delay allows the missile battery to reach nominal output voltage before launcher power is removed and the missile is fired.

2411. LAUNCHER BATTERY/COOLANT UNIT REPLACEMENT

Warning: Parts of the launcher BCU get extremely hot (400 degrees Fahrenheit) when activated and stay too hot to touch for approximately 15 minutes. Do not touch the case of a

hot BCU when removing it from the BCU receptacle.

a. To remove the launcher BCU, grasp the heat-insulated cap and twist it counterclockwise. After use, it may be discarded. Before replacing the launcher BCU, make certain that the safety and actuator device is in the safe position.

b. To replace a launcher BCU, insert it in the launcher BCU receptacle and twist it clockwise until it locks in place.

Section V. SAFETY

2501. PURPOSE

The purpose of this section is to summarize general safety procedures used during shipping, storage, handling, checking, and firing of the Redeye weapon.

2502. SHIPPING AND STORAGE

The weapon will never be shipped or stored with the BCU inserted. The BCU receptacle cap and front cover are installed and the weapon placed in the shipping and storage container prior to shipment or storage.

2503. HANDLING

While the weapon can be damaged if dropped or handled carelessly, detonation of the warhead or ignition of the motors as a result of such mishandling will not normally occur. If the weapon is dropped or there is evidence that it has been subjected to rough handling during shipment, it should be returned to the ammunition supply point. Weapons considered unsafe for shipment will be destroyed.

2504. FIRING

a. Safety Equipment.--In addition to his helmet, the gunner is required to wear a flak jacket to ensure protection under nontactical conditions.

b. Flying Debris.--Flying debris is a hazard to the gunner during firing if the launcher breech is closer than 1 meter to the ground or an obstacle is directly to the rear of the gunner. Debris from sustainer ignition at the end of the coast phase does not normally endanger the gunner in any way.

c. Ear Protection.--Under nontactical conditions, ear protection is required to prevent the gunner from suffering a temporary hearing loss as a result of being exposed to the noise of the ejector and sustainer motors at ignition. Plugs are available in the supply system for this purpose.

d. Additional Precautions.--Personnel should stay clear of the front window of the missile. There have been incidents of outward explosion of the front window caused by internal gas leaks.

2505. FIRING ANGLE LIMITATIONS

Never fire the Redeye weapon from a kneeling or prone position. Fire only from the standing position and never from a foxhole or in front of an obstacle.

a. Maximum Firing Elevation Angle.--The weapon should never be fired at a launcher elevation angle greater than 65 degrees. If firing is done at an elevation angle greater than 65 degrees, the blast from the ejector motor may cause earth and stone particles to fly upward and cause injury to the legs and body of the gunner.

b. Minimum Firing Elevation Angle.--
Because the Redeye missile tends to lose altitude during the coast phase after launch, the launcher must be elevated to a minimum elevation angle of 15 degrees before firing on level or near level terrain. Whenever tactically possible, the gunner should take a firing position on elevated terrain to obtain a clear field of fire. An elevated firing position will tend to reduce the possibility of the missile hitting the ground after launch when firing at low altitude targets which bring the launcher line of sight below the horizon.

2506. BATTERY/COOLANT UNIT

The BCU case becomes extremely hot (400 degrees) after activation and should not be touched for 15 minutes after it has been activated except on the heat-insulated ring. The launcher uses a thermal battery to power the Redeye weapon during prelaunch operation. Removal of the battery/coolant unit from the launcher can be safely done by grasping the heat-insulated ring on the bottom of the unit. Do not place the hand under the activated BCU. Grasp the sides of the insulated ring for removal.

2507. HANGFIRES, MISFIRES, AND DUDS

a. If the weapon does not function properly when the firing trigger is depressed and held down for 0.6 seconds (i.e., if the missile is not ejected from the launcher), continue to track the target for an additional 3 seconds with the firing and uncaging switches depressed. If the weapon has not fired at the end of this

time, keep the weapon pointed downrange, release the uncaging and firing switches and remove the launcher BCU. Keep the weapon oriented in a safe launch position for 10 minutes to preclude any hazard due to a hangfire. After this 10-minute wait, contact EOD personnel to deactivate the weapon.

b. In instances when the missile is ejected from the launcher and the sustainer motor fails to fire, the round should not be approached and personnel should be directed to take cover. After a 30-minute period, the round can be considered safe and should be destroyed in place.

c. Should the missile be successfully launched (ejector and sustainer motors fire) but strike the ground without self-destruction, the area should be cleared of personnel and it should be destroyed in place.

d. When the weapon must be destroyed, the services of the Explosive Ordnance Disposal Unit should be requested. Destruction should be complete so as to prevent information regarding the missile being obtained by analysis of the debris.

2508. SPECIAL OPERATING PRECAUTIONS

a. Radio Frequency Energy.--The probability of accidental detonation of the warhead by static electricity or radio frequency is extremely small. However, the weapon should not be stored, handled, or fired in areas containing high levels of radio frequency energy. Shipboard operations require special

modifications to the weapon because of this fact.

b. Weapon Movement.--Whether movement is by air, sea, rail, or motor vehicle, the weapon should be placed in a shipping and storage container (Monopak) prior to movement.

c. Battery/Coolant Hazard.--It is highly unlikely that the thermal battery inside the BCU could be accidentally activated. However, to ensure high safety standards, the batteries should not be exposed to direct high-power radio frequency energy or stored near flammable material.

Section VI. DESTRUCTION

2601. GENERAL

Destruction of the Redeye weapon or its components is performed by the FAAD team. This action is taken when, in the judgment of the FAAD unit commander, it is warranted.

a. When destruction is directed, due consideration should be given to selecting a site of destruction that will not create a hazard to friendly troops. The weapon must be destroyed so that it cannot be repaired with components from other weapons. Adequate destruction requires that key components be destroyed or damaged beyond repair. However, when circumstances prevent destruction of all key components, destruction priority shall be given to those components most difficult to replace. The seeker head must receive top priority during destruction and must be destroyed on each weapon so that the enemy cannot reconstruct one complete weapon from several damaged ones.

b. The missile can best be destroyed by firing the Redeye weapon. When the weapon cannot be fired, destruction by other means is required. In general, destruction of the essential components, followed by burning, usually renders the Redeye weapon inoperable. However, selection of the particular destruction method requires resourcefulness in the use of facilities at hand.

(1) Destruction By Burning

(a) Physically smash the seeker.

(b) Physically smash the sight and handgrip assembly.

(c) Stack all materiel to be burned.

(d) Place incendiary grenades around the Redeye weapon(s), or douse with flammable liquids.

(e) Cautiously ignite.

Warning: The Redeye weapon contains both a live rocket motor and a high-explosive (HE) warhead. The presence of explosives creates an extreme hazard to personnel when the weapon is burned.

(2) Destruction By Demolition

(a) Using $\frac{1}{2}$ pound of TNT or equivalent, prepare and place charges of explosives around the weapon(s).

(b) Determine whether electrical blasting caps and wire or nonelectric caps and safety fuzes are available for priming and detonating the charges. If nonelectric caps are used, they must be crimped to at least 2 meters of safety fuze.

(c) Connect charges with detonating cord as required to effect their simultaneous detonation. Dual-prime the charges to minimize the possibility of a misfire/hangfire.

(d) If charges are primed with nonelectric blasting caps, ignite the safety fuzes and take cover promptly. If the charges are primed with electric blasting caps, take cover before firing.

(3) Destruction By Gunfire.--Destruction by small arms fire cannot be relied upon to destroy the Redeye weapon and should be used only if no other method of destruction is available. The Redeye live rocket motors and HE warheads present an extremely hazardous

condition to personnel firing at the weapon from a distance of less than 50 meters.

(a) Physically smash the seeker.

(b) Stack or pile the Redeye weapons and related equipment.

(c) Fire on the equipment from distances of greater than 50 meters with rifles, machineguns, rifle grenades, or rocket launchers.

APPENDIX A

FAAD UNIT RESPONSIBILITIES CHART

SITUATION	REDEYE UNIT CMDS ESTAB LIAISON WITH	PRIORITIES FOR AIR DEF	IS POSITIONED BY	DISPLACES	SECURITY	SUPPORT (MESS, MAINTENANCE, SUPPLY)
Static	Redeye unit Cmdrs through ATF/LF Air Control AAW System.	Supported unit	Redeye unit leader to best accom- plish mis- sion. Coordi- nated with supported unit.	With support- ed unit.	By supported unit but not to detract from mission of supported unit. Main- tenance and resupply of Redeye weapons coordinated by Redeye unit Cmdr.	Normally, Redeye units must rely on support from supported units. Main- tenance and resupply of Redeye weapons coordinated by Redeye unit Cmdr.
Fluid	Redeye unit Cmdr, through ATF/LF Air Control AAW System.	As directed by Tactical Air Cmdr in coordina- tion with overall AAW plan.	Redeye Commander	As directed by Redeye Commander.	No inherent requirement. Redeye unit Cmdrs coordi- nate with Cmdrs respon- sible for local area security.	Redeye unit Cmdr. Dis- persions of Redeye teams may require support from unit in whose zone/position the Redeye teams are located.

APPENDIX B

TRAINING DEVICES

1. GENERAL

The successful engagement of aerial targets requires that the gunner be highly skilled in the handling and operation of the Redeye weapon. He must also make correct judgments that will result in missile launch at a time which will enable the missile to complete a successful intercept. The learning and retention of these skills require constant and continuing practice by every gunner. Maintaining gunner proficiency by the firing of actual weapon rounds is not feasible; however, the development of other training devices have met this requirement. These training devices provide a means of simulating all steps of the firing procedure except actual missile intercept of a target and include: the M76 training set, the Field Handling Trainer M46A2, the Redeye Launch Simulator (RELS), and the Moving Target Simulator.

2. TRAINING SET, GUIDED MISSILE SYSTEM, M76

a. The M76 training set (see fig. 49) consists of the M49E3 trainer, a battery charger, four batteries normally stored in the battery receptacles of the battery charger, and a shipping and storage container. The trainer requires one charged battery to conduct a mission.

b. The M49E3 trainer (see fig. 15) is made

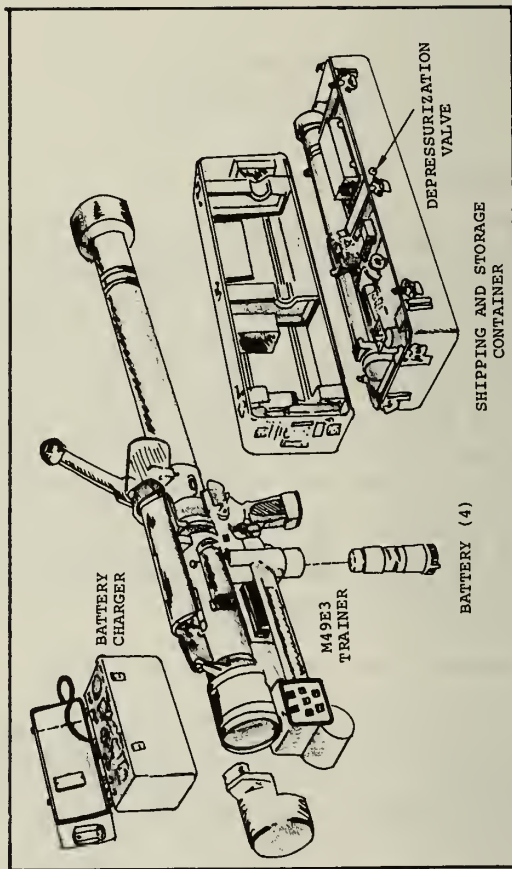


Figure 49.--M76 Training Set.

up of a launcher simulator and a missile simulator. The missile simulator is contained within the launch tube of the launcher simulator. The trainer is similar in appearance to the Redeye tactical weapon M41E2.

c. The four batteries are similar in shape to the BCU used with the tactical weapon, but are about 3 inches longer and weigh about 2 pounds more. A battery is capable of providing power for at least fifteen 31-second training missions without recharging. Each battery contains a plastic shield over the right contacts to protect the battery from accidentally discharging. The plastic shield is removed from the ring contacts only when the battery is in use during a training mission, or when being recharged in the battery charger. This shield remains in place over the rings when transporting or storing the batteries either in or out of the battery charger.

d. The battery charger (see fig. 50) is a compact, solid-state, trickle-type charger. All components are supported by the front panel of the metal housing container. Spare fuses and lamps are located in the container top under a cover plate attached by two thumbscrews. The battery charger is capable of charging one to four batteries at a time. Four independent receptacles receive the batteries, so charging of one is not affected by the others.

e. The shipping and storage container is an aluminum, two-piece shell with capacity for the M49E3 trainer and the battery charger with four batteries stored in the charger battery receptacles. A depressurization valve is provided



Figure 50.--Battery Charger.

to equalize internal pressure with the atmosphere before the container is opened.

f. The trainer has a closed-loop coolout system that recirculates freon to cool the seeker. A manually-operated pump is used to obtain the necessary pressures required for operation. Under normal conditions, at least nine training sequences can be accomplished when the cooling system is properly pressurized.

3. FIELD HANDLING TRAINER M47A2

The field handling trainer is a full scale weapon launcher ballasted to simulate the weight and balance of the tactical weapon. The field handling trainer is a rugged, inexpensive device designed to provide practice in the basic skills of Redeye weapon handling, operation, sighting, and ranging. Indications of target acquisition are not provided because the trainer does not have an infrared acquisition capability. Controls are identical to those of the tactical weapon and mechanical operation is the same. The trainer contains no active electrical components and is thus less costly and more durable than the tracking head trainer.

4. REDEYE LAUNCH SIMULATOR (RELS)

a. The RELS (see fig. 16) is comprised of standard Redeye components with the exception that the seeker is located external to the launcher tube. The weight is approximately 3 pounds heavier than the tactical weapon due to the addition of the seeker assembly. The indications received by the gunner during a training mission are in all respects the same as those of

the tactical weapon up to and including launch. There is no sustainer motor included in the trainer; therefore, missile intercept does not occur. The RELS utilizes an eject motor to ballistically launch an inert missile to a maximum range of less than 350 feet. Safety considerations require a range area clear of obstructions and personnel extending a minimum of 350 feet forward and 42 feet rearward of the launch area.

b. The RELS can be reloaded in the field by Redeye gunners. The simulated missile is inserted in the aft end of the launch tube and held fast by the nylon locking screw. The electrical connection is made by inserting the connector of the simulated missile into the receptacle located on the aft end of the launch tube. (See TM 8394-14/1.)

c. Electrical power and coolant are provided by the use of an actual BCU in the same manner as with a tactical Redeye weapon. Once used, the BCU is discarded and another BCU must be used for each additional firing.

5. MOVING TARGET SIMULATOR (MTS) M87

The MTS (see fig. 17) presents the appearance of a flying aircraft against a natural background with realistic trichannel sound effects and infrared emissions from the targets. The MTS consists of the following major components: target projection console, firing platform, observer platform, IR mirror and pedestal, projection screen assembly, loudspeakers, trainer control console, 16mm motion picture films, and a background scenery lighting system.

APPENDIX C

UMPIRE CHECKLIST FOR FAAD UNIT OPERATION

1. COMMAND RELATIONSHIPS

- a. Was the FAAD unit included in pertinent coordination briefings?
- b. Was the operation plan available to the FAAD unit? When?
- c. Was specific tactical mission assigned to FAAD unit in operation plan? Was it adequately defined?
- d. When was FAAD unit assigned to supported unit?
- e. Were FAAD teams in direct or general support or attached?
- f. At what unit levels were FAAD teams deployed?
- g. Were FAAD team assignments reviewed during exercise to achieve optimum utilization?

2. DEPLOYMENT OF FAAD TEAMS

- a. Were the FAAD teams effectively deployed during the exercise?

- b. Were the FAAD teams tactically deployed at all times during the exercise?
- c. During their deployment, were the best elements of cover and concealment used to protect the FAAD team positions?
- d. After a firing or series of firings, did individual FAAD teams move to alternate positions? If no, explain.
- e. Were the FAAD teams deployed in the best possible positions to protect the vital or assigned areas?

3. COMMUNICATIONS--RADIO

- a. What types of radios were employed?

<u>Platoon</u>	<u>Section</u>	<u>Teams</u>
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- b. What was the effectiveness of communications?

	<u>Battery</u>	<u>Platoon</u>	<u>Section</u>	<u>Teams</u>
Excellent				
Good				
Poor				

- c. Was communication security adequate?
If no, explain.
- d. Were radio batteries available?
- e. When were FAAD unit nets established?

FWC
FTC

4. TRANSPORTATION

- a. What types of vehicles were employed?

Platoon

Section

Teams

- b. Were vehicles adequate to support the exercise? If no, explain.
- c. Was helicopter movement of FAAD units used?
- d. Was fording gear employed?

5. LOGISTICS

- a. Were the FAAD teams outfitted in accordance with TAM? If no, explain.
- b. Were simulators available and used effectively?
- c. Was resupply of rations, etc., accomplished by the supported unit?
- d. Were facilities available for battery recharge?

6. TRAINING OBJECTIVES

- a. Was level of FAAD unit training satisfactory? If no, explain.
- b. Was formal training conducted during periods of inactivity?
- c. Were simulator demonstrations conducted for benefit of other aviation units

prior to exercise? What units?

7. AIRCRAFT IDENTIFICATION

- a. List types of aircraft involved in exercise.

Friendly

Aggressor

- b. Tabulate exercise results.

Date A/C Type Passes Identified

Tracked Hit

- c. List factors effecting identification (visibility, terrain, training, etc.).

8. MOTIVATION

- a. Evaluate motivation of FAAD units at following levels:

Platoon

Section

Teams

- b. Comment on methods of improving motivation.

9. CONCLUSIONS AND RECOMMENDATIONS

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Guided Missile System (U) (Confidential))

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